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Editor's Notebook

PATHS TO ECOFORESTRY: OPTIONS FOR AN ECOLOGICALLY, SOCIALLY, AND ECONOMICALLY SUSTAINABLE FUTURE

Forests form a green carpet over the land. They provide homes for a magnitude of species and perform a multitude of eco-services for the planet. Human management of forests, therefore, not only has a direct influence on the life forms therein but also on the soil, water, and atmosphere, including these elements found in more distant parts of the planet. Over the last four or five decades, industrial forestry practices have proved to be profitable for the companies themselves. But what has happened to the biodiversity of forests? This special issue of *Global biodiversity* looks at ecoforestry as an alternative to current forestry practices.

Late in 1996, I asked Herb Hammond, a Registered Professional Forester and forest ecologist with more than 25 years experience in research, industry, teaching, and consulting, to take on the challenge of assembling a variety of perspectives on managing the forest in an ecologically responsible way. He has brought together a stimulating group of papers for your perusal and reflection, and I thank him and the authors. I also wish to thank the Richard E. Ivey Foundation for funding both an expanded number of pages and a wider distribution for this issue.

Here are some of the questions that have been raised for me: **To adequately protect forests, how large an area must we preserve?** Stan Rowe argues these areas must of sufficient size to protect their ecological integrity. **What exactly is entailed in an ecoforestry approach?** Herb Hammond lays out the fundamentals while Russel Barsh contributes an indigenous perspective to managing forests. **Is ecoforestry financially viable?** Jim Smith details the results of the Vernon Log Sale Project in British Columbia while Jim Drescher and Mark Kepkay profile the experiences of a privately owned business. **Should the boreal forests of the world be logged?** William Pruitt thinks not and suggests that they should be preserved intact or even extended because they provide valuable wildlife habitat and act as a carbon bank that buffers against global warming. **How will the world meet the soaring pulp and paper needs of the future?** Heather Rosmarin argues the case for non-wood alternatives as a way to decrease pressure on forest biodiversity. **Finally, are our economic systems the root of the current degradation of forests? Are there alternatives?** Tom Green proposes that ecological economics is the only way for planet Earth to ensure her survival.

The future of our forests is at risk. I ask you to consider these papers thoughtfully, and I welcome any comments, news of success in preserving forest biodiversity, research findings from the field, and viewpoints. The time for action is NOW...before it is too late.

Don E. McAllister

Don E. McAllister
Editor

Global biodiversity gratefully acknowledges the support of the Richard E. Ivey foundation for this special issue.

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The goals of Global biodiversity are to:

- *Publish articles, views, and news on biodiversity*
- *Bridge the gaps between professional disciplines & the public*
- *Communicate vital information to help humankind make decisions on the fate of the Earth's life*
- *Express views on the needs & value of biodiversity research*
- *Provide an international forum for discussing issues on biodiversity*
- *Enhance awareness of the role of biosystematic research & museum collections to conservation & ecologically sustainable use of biodiversity*
- *Discuss methods and philosophy of biodiversity conservation*
- *Review books and periodicals on biodiversity*

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Canadian Pulp and Paper Association

Progress in marine conservation biology
Amy Mathews-Amos

Assessing insect biodiversity
Hugh Danks

Primer on parasites
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Global biodiversity

Volume 7, Number 2, Fall 1997

Forests burst with biodiversity. What can the world do to protect this invaluable resource?

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Global biodiversity is published quarterly. Annual subscription rates: In Canada $26.75 for individuals, $53.50 for institutions (includes GST). Quebec residents please add 6.5% QST. Outside Canada, US $26.75 for individuals, US $53.50 for institutions. A reduced rate of US $15.00 is available to subscribers in developing countries. Claims for missed issues will be honoured up to six months after the missed issue within Canada, and up to one year outside Canada.

Version française disponible : *La biodiversité mondiale*
ISSN 1195-3101 (English edition)
ISSN 1195-311X (édition française)

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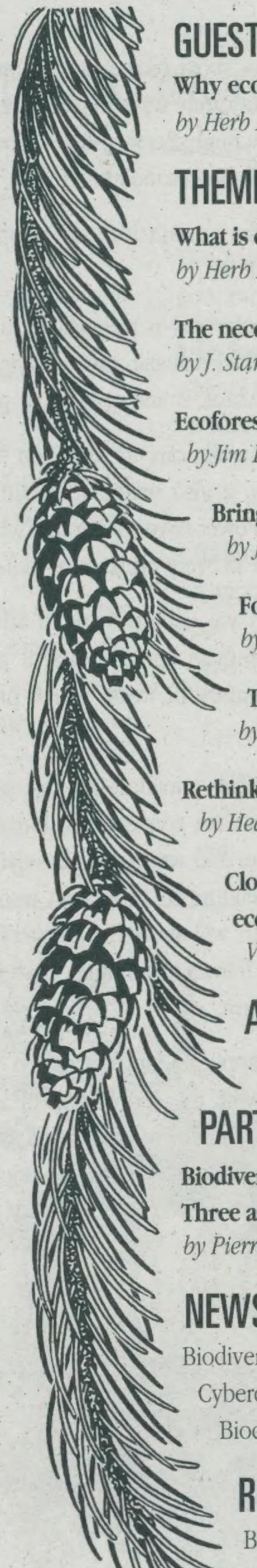

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GUEST EDITORIAL

Why ecoforestry?

Ecoforestry is about forests — about protecting the forest and related ecosystems that sustain life on Earth. Ecoforestry is not about canny ways to cut more trees or clever ways to combine logging with berry-picking and bird watching. Ecoforestry is about understanding our place as humans in ecosystems and acting on that understanding.

Ecoforestry is about future generations of people — about taking the time to provide intergenerational equity for all life.

Ecoforestry is ecosystem-based. The goal of ecoforestry is to maintain fully functioning forest ecosystems. In contrast, the central goals of conventional forestry are to maintain timber supplies and an adequate return on stockholder's investments. Conventional forestry, in other words, is timber-based or profit-based.

Human societies depend (more than we usually care to admit) on healthy, fully functioning ecosystems. Because ecoforestry maintains whole ecosystems, it also maintains healthy human communities. Sociologist Patricia Marchak and economist Thomas Michael Power have shown that when forests are degraded, human communities that depend on the forest suffer a decline in every measure of well-being.

Human economies depend (more than we usually care to admit) on healthy, fully functioning human communities. Because ecoforestry maintains human communities, it provides the options and foundations for a sustainable, diverse economy, based upon meaningful work, which provides for the whole person — spiritually, mentally, and physically.

Conventional forestry provides jobs; ecoforestry provides jobs that people love to do. While cutting fewer trees, ecoforestry can, in fact, provide more jobs than conventional forestry (by a factor of three times or more) by creating not only a wide spectrum of timber and wood product-related jobs, but an even wider spectrum of non-timber jobs, from wildcrafting to permaculture to ecosystem restoration. Because ecoforestry provides for a continuation of large, old trees, ecoforesters will always be able to supply high quality wood that is necessary for value-added wood products, from timber frames to furniture. Such diverse, community-based economies are the only sustainable economies in the long term.

Albert Einstein provided some wisdom that is applicable to ecoforestry: "A clever person solves a problem — a wise person avoids it." The lifetime of a tree starts with the germination of a seed and ends when the fallen tree finally disappears into the forest soil. This lifetime may span 500 to 2,000 years and beyond. Forests are built upon fallen trees, yet conventional forestry does not replace them. Without waiting centuries or millennia for natural processes to occur, no person is clever enough to replace fallen trees. However, ecoforestry gives us the wisdom to avoid this and other problems. Will we listen?

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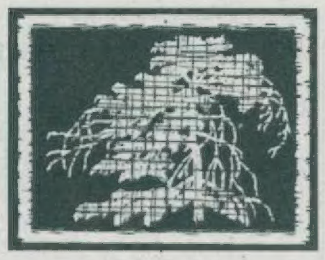

What is ecoforestry?

Herb Hammond

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INTRODUCTION

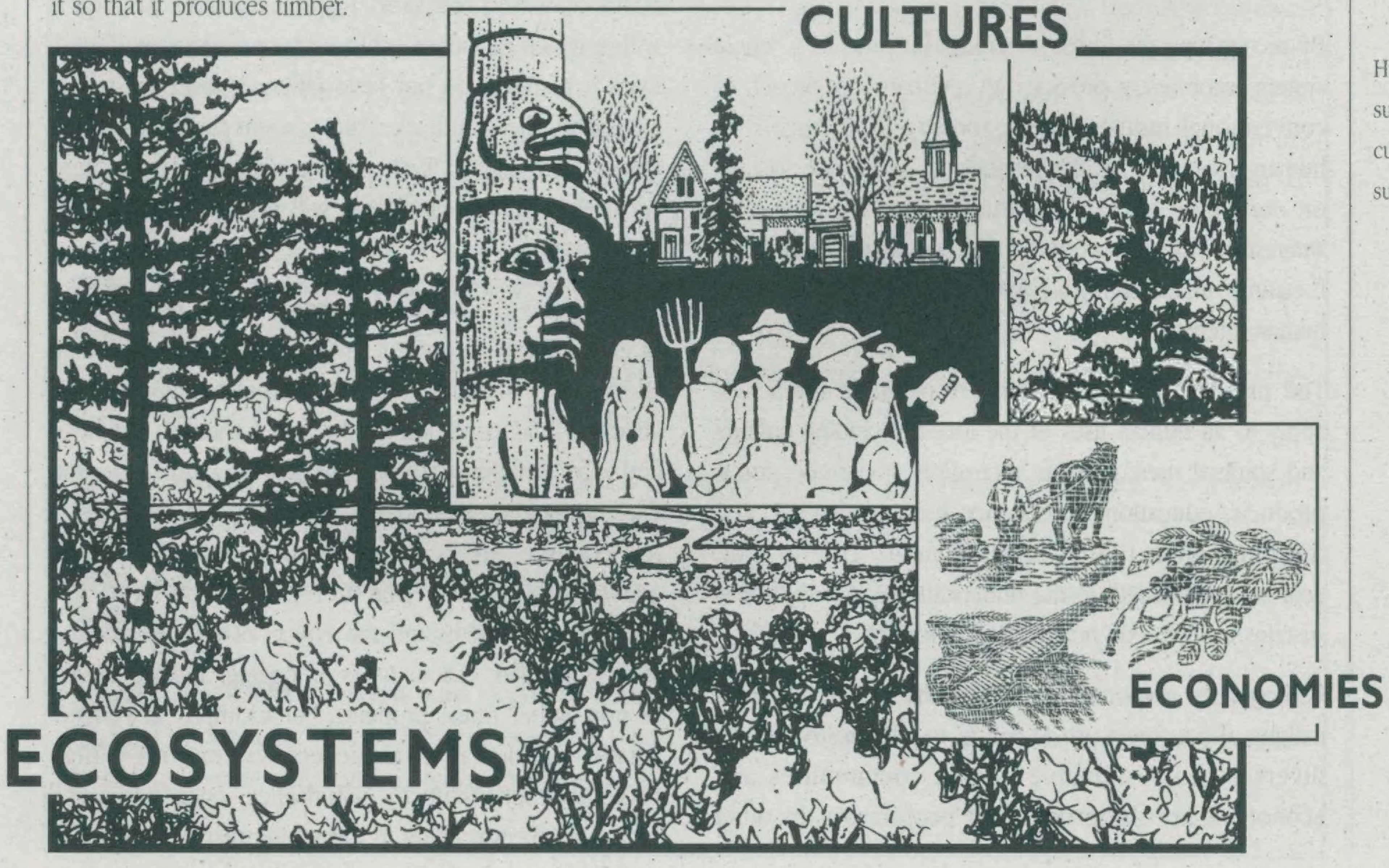
Ecoforestry is an approach to human interactions with the forest that places protection of the forest ecosystem (eco-) ahead of using the forest for human purposes (-forestry). In other words, ecoforestry recognizes that human economies are subsets of human cultures, which are subsets of ecosystems. Therefore, if we protect the ecosystem — the forest — we protect our cultures and, in turn, our economies.

Conventional forestry focuses on growing trees for timber or pulp. Ecoforestry focuses on becoming a strand in the forest web itself, while providing for a variety of human needs, from pure water and spiritual sustenance to recreation and wood products. In the context of ecoforestry, humans are *a part of* the forest, rather than *apart from* the forest. They participate in sustaining the whole; they do not separate from the forest by changing it so that it produces timber.

The practice of ecoforestry is derived from two central principles:

- **Ecological responsibility** — All human activities must be carried out in ways that protect, maintain, and (where necessary) restore fully functioning forests at all levels, from small communities to large landscapes, in both the short and long terms.
- **Balanced use** — Within the context of ecological responsibility, all forest users, human and non-human, are entitled to fair, legally protected land bases that are well distributed through the forest, sufficient to meet their needs, and adequate to carry out their functions in the ecosystem. In the practice of ecoforestry, "use" means not only "human use," but also use by the myriad of other living and non-living parts of the forest web.

Human economies are subsets of human cultures, which are subsets of ecosystems.



In attempting to describe the forest, we are challenged by a complex web of living organisms and their non-living companions. Similarly, in attempting to describe ecoforestry, we are challenged by a complex web of words and concepts. Because *ecological responsibility* is such a critical part of ecoforestry, the terms *ecologically responsible forest use* and *ecologically responsible forestry* are used synonymously with ecoforestry in this paper.

Many of the problems that surround forest use today result from our brief life spans and short memories. Industrial timber management practices, such as clear-cutting, slashburning, brush removal, tree planting, and "pest management," may be common and currently accepted, but they are by no means traditional or natural. Most trees in old growth coastal rainforests and many trees in old growth montane or mixed-wood forests are many times older than conventional timber management practices. As opposed to the "managed forest," these forests were, and continue to be, established and tended by nature — by chaotic natural disturbances that occur in unpredictable ways.

Compared with any other living organism or natural disturbance, industrialized society has an inordinately large amount of power to modify and degrade ecosystems in ways that have never occurred before in the history of Earth. A technologically equipped human being is not just another organism carrying out its life cycle in the forest. Fungi do not operate feller-bunchers.

By recognizing the forest, including humans, as a whole system, ecoforestry provides an alternative approach to conventional industrial-scale forestry. With regard to human uses, ecologically responsible forest use focuses on *managing human activities to serve the long-term interests of fully functioning forest ecosystems*, rather than focusing on managing ecosystems to serve short-term human interests.

The principles of ecologically responsible forest use apply to all human uses of the forest, including cultural and spiritual uses; tourism; recreation; non-timber forest products; education; subsistence hunting, fishing, and trapping; and timber management. Briefly put, ecoforestry is based on the understanding that the forest sustains us — we do not sustain the forest.

Ecologically responsible, community-based decision-making about forest use is critical to ecoforestry. Stable, diverse, and sustainable human communities and economies are the products of ecoforestry. In other words, ecoforestry encourages conserver societies and economies as opposed to consumer societies and economies. Conserver economies include meaningful work, labour-intensive activities, and value-added products (both timber and non-timber products) manufactured in close proximity to their forest source.

Ecoforesters do not assume that timber cutting is an appropriate forest use, even where trees with commercial value are plentiful in a particular landscape or watershed. Before any human-use activities are planned, ecoforesters first assess the characteristics of the ecosystem (how the forest functions), its condition (how human use has affected forest functioning), and its ecological limits to various types of disturbance. This assessment is then combined with other ecosystem, cultural, and economic factors to determine which human uses, if any, are appropriate, sustainable, and compatible. In addition to the two central principles of ecological responsibility and balanced use, ecoforestry is guided by ten principles (Figure 1), which are derived from both wisdom and science.

HOW IS ECOLOGICALLY RESPONSIBLE FOREST USE CARRIED OUT?

Ecoforestry starts with the development of an ecosystem-based plan at the **landscape** level. At a minimum the landscape needs to include a medium-sized drainage basin or watershed (about 5,000 hectares or larger) within which proposed ecoforestry operations are found. Even if planners do not have influence over the whole landscape, they must take into account the needs of the forest landscape. Without a landscape-level plan, ecoforestry at the stand level will not be sustainable in the long term.

To determine the **ecological sensitivity to disturbance** of each ecosystem present in the landscape or the stand (Principle 4 in Figure 1), the ecoforester assesses the character and condition of the forest through synthesis and interpretation of maps, air photos, and field data. Each type of ecosystem has specific physical attributes — for example, steep slopes, shallow soils, or a short growing season — that determine how well the ecosystem can withstand the effects of human activities such as tourism, various types of logging, and the harvest of non-timber forest products. For example, a wetland-forest complex is a fragile ecosystem with a high ecological sensitivity to disturbance; even one small group of hikers walking in the wrong place can result in

1 **Focus on what to leave, not on what to take.** "What to leave" is a fully functioning ecosystem at all scales through time. Only after determining what parts of the forest need protection to achieve this goal can we determine what may be safely removed for wood and other forest products. Understanding historical patterns of indigenous forest management gives us important information about what must be protected and what can be removed.

2 **Apply the precautionary principle** to all plans and activities. Err on the side of protecting ecosystem functioning, rather than on the side of protecting short-term profits or annual timber-cutting quotas. If we are not sure that an activity will protect, maintain, or restore ecosystem functioning, then we must not do it.

3 **Design forest plans on temporal scales of 500 years and beyond and on large spatial scales** that embrace as large a landscape as is practical, given political and ownership constraints. Generations of people will live through and apply these long-term *forest plans,* which are different than short-term *logging plans* that foresters and accountants use to maximize corporate return.

4 **Respect the ecological limits of various ecosystems to human disturbance.** Ecological limits are physical and biological factors that indicate that various human uses may result in unacceptable levels of modification or degradation of forest ecosystem functioning. Common ecological limits include shallow soils, very dry or very wet sites, very steep slopes, broken slopes (abrupt slope gradient changes that occur regularly across a small landscape), very dry climates, cold soils, snow-dominated forests, and riparian ecosystems. The presence of ecological limits means that economically viable volumes of good quality timber cannot be cut and grown sustainably without lasting damage to the forest and interconnected ecosystems.

5 **Protect, maintain, and, where necessary, restore natural biological diversity.** This includes genetic, species, community, and regional diversity.

6 **Protect, maintain, and, where necessary, restore natural composition, structures, and functions** at the landscape and stand levels. Maintaining natural disturbance regimes (for instance fire, windthrow, and insect and disease activity) through time and space is the primary way to maintain natural forest landscape patterns. Take into account the condition of the forest and the presence of human communities and infrastructure. For example, if fire has been excluded from a forest landscape for extensive periods of time, restoration of "near natural" stand composition and structures throughout the landscape will be necessary before fire can be successfully reintroduced. Old trees, large snags, and large fallen trees are important stand-level structures to maintain because they require centuries or millennia to replace.

7 **Protect, maintain, and, where necessary, restore forest ecosystem connectivity** at all scales of time and space. Establishing protected networks of ecosystems that include riparian ecosystems, old growth forests, and a variety of ecosystem/habitat types is essential to maintaining connectivity from the landscape to the stand levels.

8 **Diversify activities** to encourage ecological, social, and economic well-being and stability. Adapt human forest uses to the natural diversity of values offered by local forests.

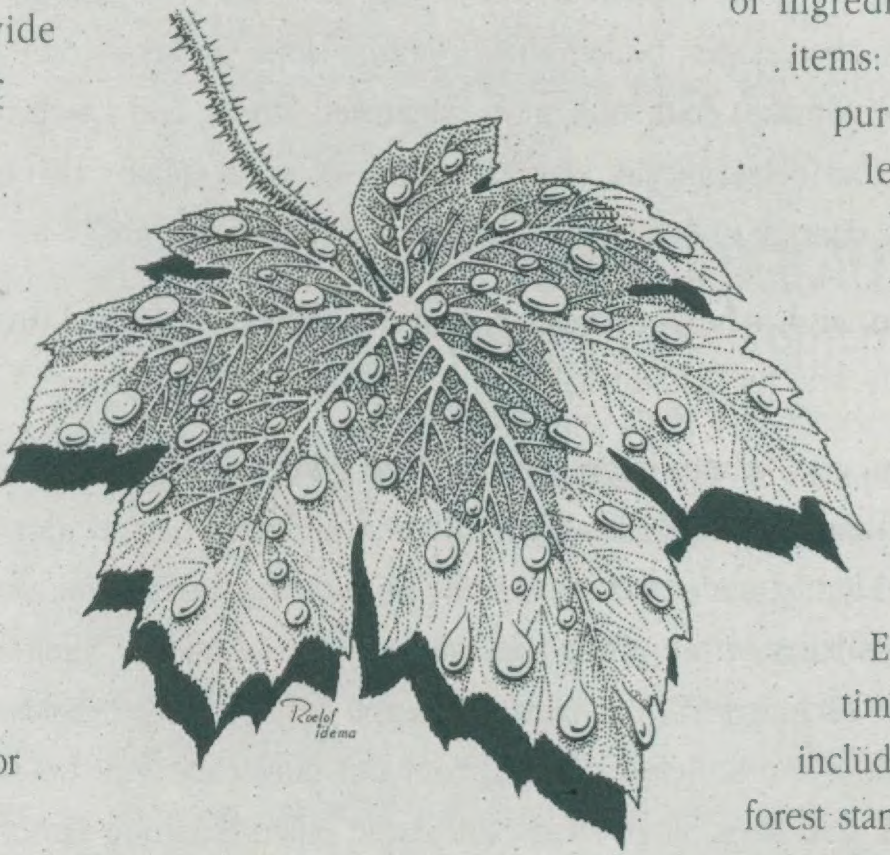
9 **Respect indigenous culture,** both traditional and current, and allow for its protection, maintenance, and, if necessary, its restoration.

10 **Constantly review and evaluate** all forest use activities. How did we do? Is forest ecosystem functioning being protected, maintained, and, where necessary, restored? Are forest uses balanced and providing for a diverse, community-based economy?

Figure 1.
Ten guiding principles in the practice of ecologically responsible forest use.

erosion of unstable soils. In contrast, a white spruce-lodgepole pine forest on a level, well-drained site is much more resilient. Subject to landscape considerations, such a forest would likely be able to withstand careful selection or partial cutting of timber without significant damage to ecosystem functioning.

Next the ecoforester determines the **ecological limits to human use** for the area by combining ecological-sensitivity-to-disturbance ratings with information about overall ecosystem functioning, species present, and the relationship of the ecosystem to the rest of the landscape, including cultural and spiritual factors. The ecological limits to human use define the short- and long-term impact of specific human activities on ecosystem functioning and on human culture (Principles 5 through 9). For example, although the white spruce-lodgepole pine forest described in the previous example has a low ecological sensitivity to disturbance, it may provide valuable winter habitat for moose, contain sites of cultural importance to First Nations people, and/or have a high potential for the harvesting of non-timber forest products such as mushrooms, berries, tree resin, and medicines. Therefore, the ecoforester, working with the local community, may deem the area inappropriate for logging.



After data collection, analysis, and planning are completed, a planning map of a typical watershed or landscape planned for ecologically responsible forest use looks like Swiss cheese. The "substance" of the cheese is reserved as a **protected landscape network** where only the softest human uses, if any, are permitted. Included are riparian ecosystems, both ephemeral and year-round water courses; old growth nodes; ecologically sensitive areas; cross-valley movement corridors; and representative forest ecosystem types for the landscape in question. Appropriate and ecologically sustainable human uses are planned for the "holes" in the cheese, and are designed according to the ten general principles (Figure 1) and additional specific standards for each type of use.

Ecologically responsible forest use options for a First Nation or forest-based community encourage a diversity of forest-based enterprises, including those based on non-timber forest products, traditional cultural skills or crafts, and existing or potential community-based endeavours. For example, Wabauskang Wildfruits, on the Wabauskang Indian Reserve in Ear Falls, Ontario, produces and markets a product called Wild Blueberry Spreadable Fruit. The label on their jar says:

> WABAUSKANG WILDFRUITS is a project led by native Ojibway women whose goal is to achieve self-sufficiency for traditional Native people in Northwestern Ontario. Wild Blueberry Spreadable Fruit is made to a traditional recipe to capture the unique flavour of wild blueberries hand-picked by Native people in Ontario's north woods.

The product is certified organic, and the list of ingredients includes only three items: organic wild blueberries, pure wildflower honey, and lemon juice. Wabauskang Wildfruits is a good example of ecoforestry.

HOW DO ECOFORESTERS CUT TIMBER?

Ecologically responsible timber management *may* be included as one human use for forest stands within a landscape-level ecosystem-based plan. If so, timber management plans and activities are developed and carried out in ways that protect, maintain, and restore (where necessary) a *fully functioning forest ecosystem* at all temporal and spatial scales. Five key standards apply to this method of timber management at the stand level:

- Design and establish a protected ecosystem network within the stand.
- On each timber management area, permanently reserve from cutting approximately 30% of the large old trees, well distributed spatially and by species. As these trees grow old and die to form future large snags and fallen trees, replacements need to be designated, so that permanent cover of large, living trees is always present on the area.

- Protect at least 50% of the large snags and large fallen trees from damage during timber cutting and other timber management activities. Maintaining large old snags provides "pest" management, because snags are homes to cavity-nesting birds that eat insects, which eat trees. Large decayed fallen trees are nature's water storage and filtration system, and the foundation for future forest soil.

- Maintain natural successional patterns, including healthy populations of a variety of forest insects and fungi, to ensure the development of healthy forests. Trees need mycorrhizal fungi, which need decaying wood from fallen trees. Forest change maintains the forest.

- Base timber-cutting rates on a cautious estimate of the composition and structures that must be protected in order to maintain short-term and long-term forest functioning.

Many other practical ecoforestry standards are applied to successful ecologically responsible timber management, including additional standards that are specifically modified to meet local ecosystem characteristics and conditions. More information about additional standards can be obtained from my book *Seeing the Forest Among the Trees* (Hammond 1991).

WHAT'S STOPPING US?

Profit-based corporate interests claim that they are developing a sustainable global economy. However, this economy is based on damage to and often destruction of its very foundation — the forest and diverse, community-based economies. We have failed to realize, as Paul and Ann Erlich put it, that "the economy is a wholly owned subsidiary of natural ecosystems."

Most of us have been taught or conditioned to confuse trees with forests, groups of people with communities, consumer economies with sustainable economies, and laws with justice. If we lived a thousand years or more, we would think differently. We would probably refuse to allow constant cropping of trees as prescribed by industrial-scale forestry because we would understand the inevitable outcome of these activities: the degraded forests, the spoiled water, the lost species, the infertile soil. In Europe and parts of Asia, these problems are already evident. In North America, they may happen more quickly due to increased global ecological stress from climate change and ozone depletion.

The time to begin practicing ecoforestry is *now*. We all need to reassume responsibility for our local communities and economies by protecting, not degrading, the forest. One thing that will help is to *think like the forest*.

If you doubt the necessity of moving from a profit-based approach to an ecosystem-based approach, please consider the words of Martin Luther King:

> We are now faced with the fact that tomorrow is today. There is such a thing as being too late. Over the bleached bones of numerous civilizations are written the pathetic words: "Too late." If we do not act, we shall surely be dragged down the dark corridors of time reserved for those who possess power without compassion, might without morality and strength without sight.

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Restoring Nature's Place

A Guide to Naturalizing Ontario Parks and Greenspace

Jean-Marc Daigle and Donna Havinga

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WHAT IS A FOREST?

We need trees to have a forest, but also need a forest to have trees.

A forest is...

...an interconnected web that focuses on sustaining the wholes, not on producing any one part or commodity. The forest web consists of animals, plants, microorganisms, light, water, soil, and rocks arranged in infinite diversity across scales that range from soil fungi to the continents of Earth.

...a pattern of independent ecosystems across landscapes from small watersheds of 5,000 hectares to the largest watershed of all — the one we call Earth.

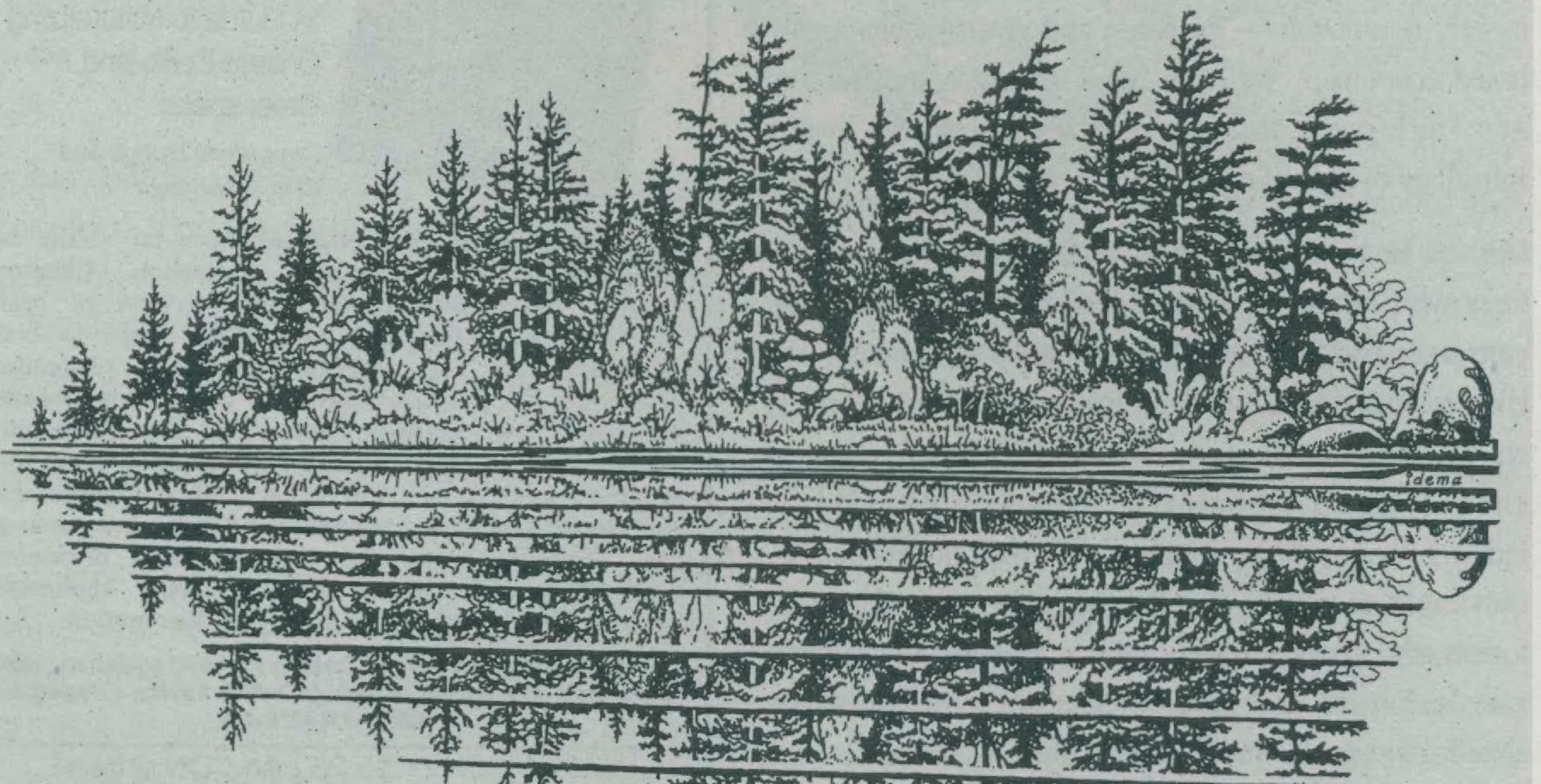
...a continuum in time from the ephemeral to the eternal. Living organisms and non-living structures support each other's existence and rely on each other's demise in endless cycles.

...change — from the falling of a single leaf to landscape level fires. Change maintains and renews the composition and structures of the forest at all scales through time.

...diversity created by disturbance, protecting the whole.

...living trees that form part of the structural framework of the forest web. Large old trees are especially vital parts of this framework. Some insects and small mammals live out their lifetimes within the canopies of large old trees. Crowns of large old trees regulate water movement through the forest and beyond.

...dead trees (snags and fallen trees) that form another part of the structural framework for the forest. Generally speaking, the larger the dead tree, the more diverse and long lasting its functions. Snags are homes for cavity-nesting birds that eat insects that eat trees. Fallen trees are the foundation for future forest soil. Decayed wood is nature's water storage and filtration system.



The necessity of protecting ecoscapes

J. Stan Rowe

"Scientists have a very rudimentary knowledge of biodiversity," said Solbrig in 1991. The accuracy of this statement will stand unchallenged for many years. Worldwide, only about 1.4 million species of organisms have been described, out of probably 30 or 40 million. In Canada, Mosquin et al (1995) place the number of identified species — the big ones — at around 70,000, which means that at least many thousand little ones are lurking undiscovered in the northern mountains, wetlands, forests, estuaries, grasslands, tundra, and oceans. New species are being discovered all the time. Clearly, the biodiversity of any area depends on its "taxodiversity": the numbers and kinds of taxonomists who have packed (or been packed) into it!

Naturally evolving organisms are inseparable from their landscape/waterscape systems ("ecoscapes"), which — unlike organisms — are relatively easy to identify. Therefore, a preservation program for terrain in its inclusive sense is a logical way to compensate for taxonomic ignorance. Every ecoscape that we can maintain in a natural or semi-natural state becomes a sanctuary for the known and unknown species within it.

Our education system does not teach the inherent value of the systems within which species dwell. True, the importance of "community" is frequently emphasized but, by itself, the concept of community is incomplete. It is a name for a group of organisms sharing the same area but does not suggest their ecological relationships and dependencies. But, placed in the context of ecoscape — where air, waterforms, landforms, sediments, soils, and climate provide a substantial matrix — the idea of community gains a complete structure and functional form that is one definition of "ecosystem." Ecosystems, sectors of Earth or Ecosphere, are the source and support of communities of organisms, including us, *Homo sapiens*.

ON SAVING LIFE

We are tackling the problem of preserving "life" from the wrong end. In past times, human intuition attributed "life" not only to organisms but also to what surrounded them: to Earth, to water, to the *anima* and *animus* of the air — and why not? Whatever that mysterious organizing principle called "life" may be, its immediate source is clearly the Ecosphere. Organisms and their earthly matrices are symbiotic and inseparable, differentiated only by our deceitful sense of sight. A creative animating process, life is an expression of the Blue Planet and its 4.6 billion years of evolution. The Biological Fallacy, which equates organisms with life, is the result of a faulty inside-the-system view (Rowe 1992).

A simple thought-experiment points out the differences between seeing an organized system from the outside and from the inside. First, suppose that we are students looking through microscopes at a slice of plant tissue. We see spaces bounded by walls, and we know (because the instructor tells us) that the unitary things we are seeing are called cells. Looking within, we are mentally prepared to see parts: nuclei, plastids, mitochondria, starch grains, streaming cytoplasm, particles dancing in Brownian movement. Note that the identification of *parts* is contingent on our prior definition of the *whole*.

Now imagine that before seeing cells from the outside, we were reduced to microscopic size and placed within a cell. The teacher hands binoculars to us and asks, "What do you see?" Sight from within particularizes. Lacking the outside perspective that reveals the whole, we will see the cell contents as separate and unconnected objects. We might then logically identify the dividing, reproducing organelles as *alive* and their cytoplasmic matrix, vacuoles, and plasma membrane as *dead*. The idea that the totality is alive, so obvious from the outside, is not apparent from the inside.

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Like the micro-students inside a cell, people are immersed in the Ecosphere. We are deep-air animals, sandwiched at the phase boundaries where water and atmosphere meet land. Looking around through the spectacles of Western culture, we have mistakenly identified all manner of things as "organic" and "inorganic," "biotic" and "abiotic," "animate" and "inanimate," living" and "dead." Dictionaries full of nouns show the efficiency with which we have thought the world to pieces. Around our taxonomies of ignorance, we have constructed religions, philosophies, and sciences that fragment and departmentalize a global ecosystem whose "aliveness" is as much expressed in its improbable atmosphere, crustal rocks, seas, soils, and sediments as in organisms. When did the organizing, energizing force we call "life" begin? When the Ecosphere itself was born, if not even earlier.

When life is understood as a function of the Ecosphere and its sectoral ecosystems, the subject matter of biology is cast in a bright new light. Earth spaces begin to look as important as Earth species. When animation is located where it belongs, the focus is shifted to ecological diversity, to the diversity of terrestrial and aquatic ecoscapes, the creative entities to which organisms belong and from which they came. Without this broader concept, we tend to concentrate too narrowly on "saving organisms and their habitats" — an unattainable goal that abandons unknown species and encourages one-shot technological solutions such as building high-tech arks: bigger zoos and wildlife ranches, seed banks, and botanical gardens.

THE IMPORTANCE OF LANDFORM TO "LANDSCAPE LEVEL" BIODIVERSITY

Land-based naturalists know that to find different plants and animals, they must go to different kinds of landforms: to sand plains, to hummocky moraine, to rock outcrops, to bogs and fens, to hills, cliffs, valleys, to north-facing and south-facing slopes. In short they must visit the full range of landform/soil/local climates *sites*. Further, they know that on these sites they will find different flora and fauna according to stage of succession (time since disturbance) as initiated and influenced by fire, wind, flood, pathogens, or human modification. Thus, ecosystem diversity is the expression of different disturbance regimes superimposed on the diversity of terrain.

Landscape ecosystems are dynamic three-dimensional sectors of the Ecosphere, consisting of an atmospheric stratum overlying a soil/water stratum with organisms clustered at the phase boundaries. Soil scientist Hans Jenny (1941) made the argument for five relatively independent "genetic" influences on soil formation: relief/topography, geological parent material, climate, biota, and time. The same "genetic" influences shape landscape ecosystems. If within a region any four of the five are held constant, then variations in the fifth will be faithfully reflected in ecoscape variability as in soil variability. By combining relief/topography and geological parent material, we can simplify Jenny's formulation to yield four genetic influences: *landform* (defined as surface relief/topography as well as composition of the surficial parent material), *climate, biota*, and *time*. It follows that within any moderately uniform climatic region (macro, meso, or micro), given an equivalent *time* span and equal access overall to the same *biota*, all fundamental variations in landscape ecosystems can *initially and fundamentally* be attributed to variations in landforms as they modify radiation and moisture regimes, select the "fit" plants and animals from the available biota, and modify the formation of soils on their topographic facets.

The biota, although strongly responding to and reflecting the influences of landform, is also influenced by ongoing landscape processes. Therefore, ecosystem diversity is the expression of different disturbance regimes and processes superimposed on physiographic diversity. This means that the protection of forest biodiversity requires protection of the entire range of forest types in *all* their successional stages, from youth to old age, *on each different kind of landform within each major region:* on colluvial slopes, in till uplands, on outwash plains, on lacustrine and alluvial flats, on sand dunes, on organic soils. For example, the World Wildlife Fund's "Protected Areas Gap Analysis Methodology" is soundly based on identifying "enduring features of the landscape" — that is, on identifying landforms as surface materials and soils along with their topography/relief — in order to delineate sources of ecological and biological diversity within the country's natural regions.

Because of the periodic disturbance and dynamism of natural ecosystems, they can only be preserved as parts of regional complexes that have large protected nodes and connecting corridors (particularly riparian corridors) to allow for back-and-forth migrations and gene flows. The ideal, if ever it can be attained, is the "Swiss cheese model" (Hammond 1991) where the holes are the nodes of human activity embedded healthfully in the larger nature-matrix. This idea implies land-use planning on a grand scale and with a long time horizon.

HOW MUCH IS ENOUGH?

The human species steadily pursues its own exclusive monoculture, pushing aside and destroying biological and ecological diversity while giving lip service to preservation of the Ecosphere. To slow the trend requires strict preservation of large tracts of Earth's surface. How much is enough?

Odum (1970) suggested that 40% of his home state of Georgia should be preserved in the natural (undomesticated) condition, allotting 30% to food production, 20% to fibre production, and 10% to urban-industrial systems. This could be done, he said, without affecting the standard of living. Odum and Odum (1972) proposed a 50-50 split between natural lands and cultural lands for southern Florida.

Through numerous studies, Noss (1992a, 1992b) also arrived at a figure of 50% of land/water in a natural state, which he called "a credible estimate of what it takes to maintain viable populations of large carnivores and to represent at least some landscapes where natural disturbance regimes can operate unimpeded."

> **"The protection of forest biodiversity requires protection of the entire range of forest types in *all* their successional stages, from youth to old age, *on each different kind of landform within each major region.*"**

Mosquin et al (1994) adopted the "ideal balance" of land uses envisaged by Naess (1989), recommending "that the provincial and federal governments cooperate to develop land use legislation, policies and zoning aimed at the ultimate goal of allocating about one third of the lands and water in each ecozone...for the purpose of retaining and/or restoring wild species and natural ecosystems where the laws of nature would operate (as they have in the past) without major human intrusions." Nothing less, they argue, can maintain the vital "ecological functions" of the world. They propose one third zoned to meet humanity's essential productive and living needs, one third for sustainable extraction of biological resources, and one third for "wildness."

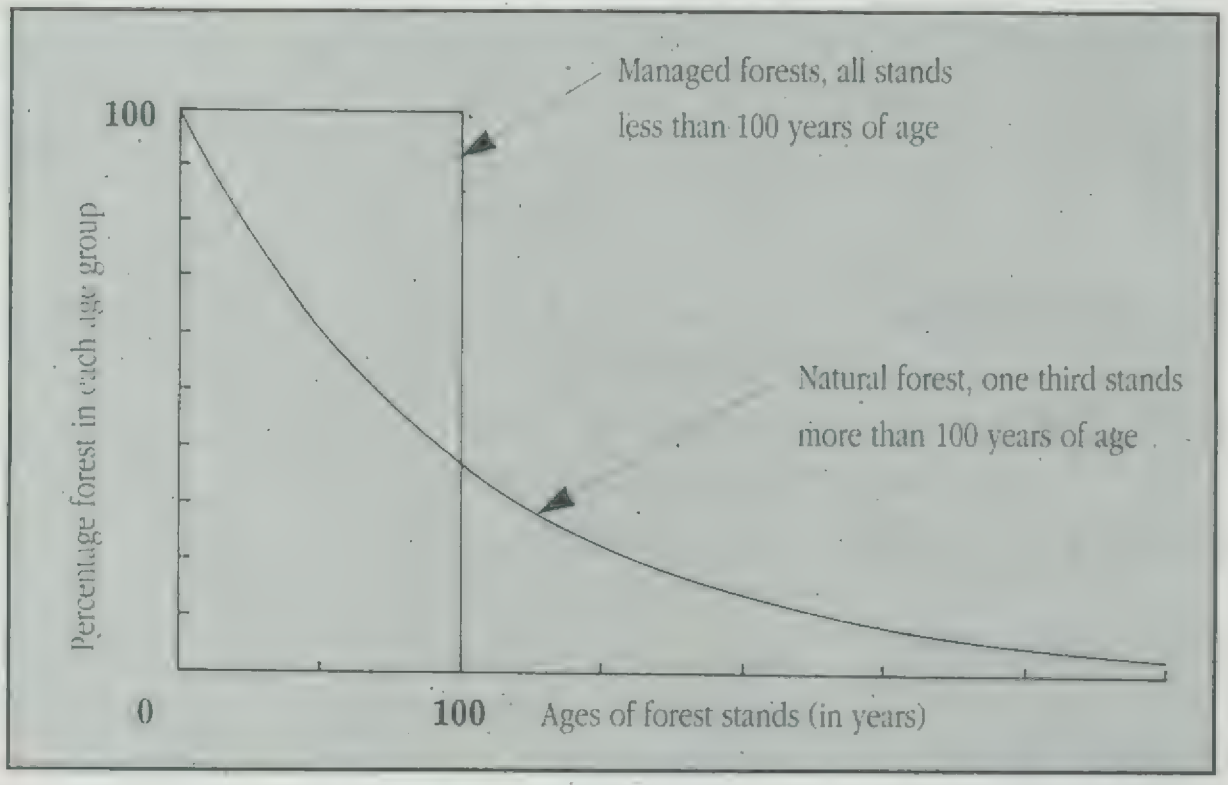
Given such estimates and warnings, the message for humanity is: Stop further destruction of wild and semi-wild continental and oceanic ecosystems *right now.*

At the moment, the popular figure for land/water preservation in Canada is 12% by the year 2000, a target first suggested by the Brundtland Commission's *Our Common Future,* then sponsored by the World Wildlife Fund and endorsed by provincial and territorial governments. The target has been interpreted in some quarters as the ransom that will set industry free to carry on as before. The idea is to zone out 12% and devote the other 88% to conventional multiple use or single industrial ends — a "triad" of forest land allocations (Seymour and Hunter 1992). According to this logic, when applied to forests, acceptance by provincial and territorial governments of 12% as the goal for "full protection forests" leaves 88% of forest land available for human exploitation at all scales, from private woodlots to industrial fibre farms. Obviously, this will not protect ecodiversity and the biodiversity that is a component of it.

The alternative in the forest domain is a system of protected forest ecosystems *plus* reform of practices outside them, so that all ecosystem values are maintained (Burton et al 1992). As long as conventional industrial forestry is accepted as valid, and perpetuated on some large fraction of forest land, its values will continue to be "the norm," obscuring the need for a fundamental change in land use practices.

In those semi-natural ecosystems devoted to extractive pursuits such as logging, management practices should heed the historic patterns (spatial and temporal) of wild ecosystems, thus giving rare animals and plants a chance to save themselves. The only way to preserve biodiversity while continuing to extract timber is to practice silviculture and harvesting within large regions in ways that maintain landscape ecosystems in mosaic patterns that approximate or mimic natural mosaic patterns. For example, in lightning-fire-induced boreal forests, the pattern seems to be a few very large irregular patches containing unburned inclusions, middling numbers of intermediate-sized irregular patches, and a very large number of small irregular strips and patches. Studies of age-class distribution in the boreal landscape indicate that age classes roughly fit a negative exponential curve; i.e., a great many young stands, an intermediate number of middle-aged stands, tailing off to mature and overmature with the latter occupying about 30% of the area (Van Wagner 1978). With an average fire rotation of 100 years, this means that the normal distribution of forest ages will show about one third in "old growth" (Rowe 1983, 1993).

Comparison of stand ages in natural and managed forests. (Source: Van Wagner 1978)



CONCLUSION

The old Cartesian dualism positioned humans as the conscious thinking centre pitted against a dead and menacing world. In revealing our relationships to all other organic things, Darwin and the biology that came after him softened this view, but did not fundamentally change it. Organisms are still centre stage and, in conventional thinking, biotic confronts abiotic, the animate confronts the relatively worthless environment.

This message is wrong. Life is not a property of organisms alone. Life is a property of the whole, of the Ecosphere and its ecosystem sectors, its ecoscapes, its three-dimensional landscapes and waterscapes with all their matrix components.

Earth spaces are endangered. Because of their evolutionary creativity, Earth spaces are more important over the long run than the species abstracted from them. Without this insight, conservationists will keep slipping back into the language of saving organisms and their habitats, leaving the door open to those who argue that the solution is more and better arks. To plan the preservation of "biodiversity" at the land-water ecoscape level is to preserve more than that term initially suggested. It is to preserve the world.

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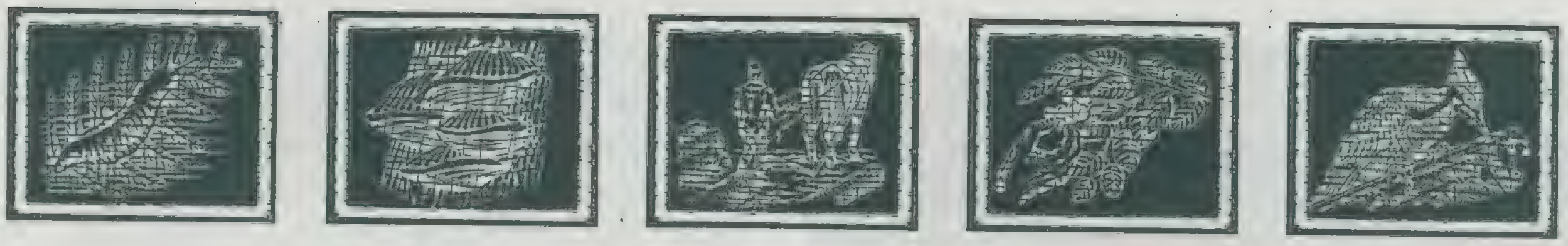

Ecoforestry at Windhorse Farm: Profile of a working operation

Jim Drescher and Mark Kepkay

HISTORY

Now it is called Windhorse Farm. Until 1840, it was undifferentiated Acadian forest, dominated by eastern hemlock, sugar maple, yellow birch, beech, red spruce, white pine, and oak. One hundred and sixty years ago, Stephen Wentzell came up the east side of the LaHave River, crossed over below a long, wide stillwater, and cleared a hole in the forest. He built a home in the middle of that large canopy gap near the stillwater that became known as Wentzell's Lake. The soil was deep and fertile, both in the valley bottom and on top of the drumlin to the west.

For three generations, the surrounding woodlands were managed according to a very particular set of principles and practices; today we would call this "ecoforestry." Logging took place in the winter; the logs were sawed into lumber in the water-powered mill below the lake, and the lumber was used by the Wentzells to build a home, barn, and outbuildings. Surplus wood was sold in the local community to raise money for taxes and the few necessities that could not be produced on the family land. In the spring and summer, work moved to the gardens and fields, and in the late fall and winter, back to the woodlot.

The Wentzells cared for the land and they prospered. They cut only the slowest growing trees. They opened gaps in the canopy just large enough to promote thickets for wildlife and keep white pine in the stand. They did not cut the tallest trees, they protected the riparian zones, and they limited their consumption to what their land offered. The family credo seems to have been, "If it comes from this land, it belongs here; if it doesn't, we don't need it."

The last Wentzells to steward the land were Carroll, grandson of Stephen, and his wife Marion. They had no children; however, they left a legacy of sane forestry to the next caretakers, Margaret and Jim Drescher. With two of their children, Marguerite and William, the Dreschers moved into the old farmhouse in August 1990. Early in their residency, they realized that Windhorse Farm provided more than enough for them, and they opened the gates to family, friends, and visitors. Some stayed longer than others and took on varying degrees of responsibility for the care of plants, animals, people, and machinery. Every visitor contributed. One early resident, Mike Higby, suggested the beginnings of what became the Ecoforestry School in the Maritimes. Another friend was John Murray, whose functional art-from-wood and capable woodsmanship inspired what is now Ecoforestry Wood Products Ltd., a lumber processing and wood-products manufacturing facility.

> The dump behind the garage, which contained most of what the Wentzells discarded for one and a half centuries, covered the area of a small bedroom to the depth of its bed. Many North American households today dispose of more in one month than the Wentzells did in 150 years. The key to sustainability is minimum consumption; the inevitable consequence for the forest is reduced logging pressure.

Today, one centre, Windhorse Farm, reaches in three directions. It is a family farm producing certified organic vegetables, herbs, fruit, and flowers; it is a lumber business that guarantees to its customers that their purchases have not contributed to the destruction of forests; and it is a learning place, teaching all of us the principles and practices of sustainability for forests and forest communities. The latter two of these directions are discussed below.

HARVESTING AND SELLING WOOD

The primary means of financial support for Windhorse Farm is the sale of wood products. We spend three months each winter horselogging on the 100-hectare (250-acre) woodlot, half of which is "ours," half the

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Logging takes place in the winter; sawing, drying and making "value added" products in the spring, summer, and fall. (Photo: Jim Drescher)

neighbour's. Trees to be harvested are usually selected individually (the slowest growing ones, but never the tallest), however occasionally groups of up to five dominant trees are cut for the two reasons Carroll Wentzell pointed out: to provide shelter for wildlife and to allow the shade-intolerant white pines to remain in the stand. These selection methods mimic the non-catastrophic natural disturbance regimes of this region and ensure that natural seeding, from the large old trees that have been protected throughout the woodlot, will provide for the continued regeneration of the forest. Our annual allowable cut is 75,000 board feet, which is about 60% of the annual growth increment. We purchase another 50,000 board feet from other ecoforestry woodlots, paying a considerable premium in recognition of the non-exploitative management and logging practices employed by their owners.

Throughout the spring, summer, and fall, all the logs are sawed into lumber with our portable bandsaw mill that goes to the log brows (stacks of logs ready for sawing) in the woodlot. This reduces the yarding distance for the horses and ensures economic viability for the horselogger. Only the lumber is removed from the woodlot; this means the slabwood and sawdust remain in the forest where they continue to provide habitat, contribute nutrients, and slow the water — all at the same time as serving as road material. The narrow sawdust/slabwood roads, trails, bridges, and landings that support this system are built and maintained to keep soil erosion and stream sedimentation at insignificant levels.

The lumber is air dried in the forest, in lumber drying sheds, or in the open lumber yards, depending on species and grade. After air drying, the best grades are kiln dried in a dehumidification kiln heated by water from a wood-fired boiler. The kiln-dried lumber is manufactured into flooring, panelling, wainscotting, custom mouldings, picture frame stock, and various other high value products. This translates into more value and employment from a smaller volume of harvest.

We also have developed alternative uses for logs that usually are sold for pulp or firewood. For example, we make "Linking Logs" from small-diameter eight-foot logs. This product, used for small buildings or retaining walls, nets over twice the income than we would get if we sold the logs for pulp. Logs with too much sweep (curvature of the stem) to make lumber are split into two or three matched, arched bridge stringers, the horizontal timbers that support the 3-inch hemlock decking. Stringers and decking together are sold as "Arched Bridge Kits" a product much more valuable than the equivalent volume of construction lumber. Even normal spruce and hemlock lumber is dried and dressed before being sold for construction uses, thus adding value and keeping as much biomass as possible at home where it can contribute to the richness of the land. For example, the shavings are used as bedding for animals, then composted and spread in gardens, orchards and pastures.

OUR EDUCATION NEVER ENDS

Everything we do here is an educational experience. The Ecoforestry School is fully integrated into the working woodlot-farm and lumber business. We study and practice what we need to learn, which includes how to design and manage an ecoforestry woodlot, how to operate a profitable ecoforestry wood business, how to build a productive permaculture, how to provide service in support of our community, and how to establish and maintain a place of continual learning for ourselves and others. Our ecoforestry discipline is inseparable from washing dishes, growing food, milking cows, keeping bees, restoring wetlands, shoveling sawdust, stacking lumber, making cheese, cutting firewood, and so on.

The ground practice in ecoforestry is to discover our fundamental, selfless, heart connection with the forest. (Photo: Margaret Drescher)

At Windhorse Farm, the first priority — the ground practice in ecoforestry, the practice that forms the foundation for real sustainability — is discovering our fundamental, selfless, heart connection with the forest. This discovery, or perhaps rediscovery, is made simply by being in the forest, doing as close to nothing as possible. In this way, we allow forest creatures and forest processes to express themselves in their own ways, on their own terms; out of that experience we can begin to recognize and explore our essential connection with, and dependence on, the forest. This is the core practice from which an ecoforester, capable of discriminating good and bad forest use, even at very subtle levels, grows. A knowledge of science, technology, and economics alone will not do this. Without a genuine concern for the whole forest in one's own place, even ecoforestry can become merely another rationalization for materialism, or perhaps "spiritual materialism." However, given the time, space, and open mind, the connections will be made, and a firm foundation for the practice of ecoforestry will be laid.

Guided by our heart connection, we then proceed with a second concern: to study forest-related science, economics, and appropriate technology. Geology, chemistry, hydrology, botany, natural history, watershed ecology, and conservation biology form necessary parts of the ecoforester's knowledge base, as do the economic subjects of full-cost accounting, rural economic development, import substitution, and bioregional trade. Of course, inquiry into, and experimentation with, small-scale technology is essential as we hone our ability to live, work, and thrive in this forest over the long term. Reading and discussion, both formal and spontaneous, are supplemented by work with, and talks by, visiting teachers of a variety of disciplines and viewpoints.

Our third general task is to do everything with our own hands. The Windhorse Farm experience is not academic, hypothetical, or predetermined. It is real: the products are real, the mistakes are real, the food is real, the cold is real, the joy is real. Only the outcome is uncertain.

ECOFORESTRY PRINCIPLES

Three ecoforestry principles guide our lives and work: an ecological one, an economic one, and a social one. A general practice is linked to each principle, and related specific practices have been developed for this particular woodlot. Results are continually monitored by applying simple tests for success. This "sustainability matrix" was presented by the authors in an ecoforestry intensive short course at Windhorse Farm in August 1996. It will continue to evolve in future courses. Although space here does not permit elaboration of details, a general outline follows.

Ecological principle

The natural forest is the primary product of ecoforestry; all extracted material is "by-product."

Practice: Manage for natural ecological diversity, not only species diversity but also diversity of age and size of all species, of structure (for example, canopy levels, fallen trees, and stream habitats), and of genetics. First, protect sensitive areas, rare habitats or ecotypes, and landscape connectivity. Next, restore diversity where humans have reduced it. Finally, harvest timber and non-timber products while causing as little change as possible in the natural diversity and the processes that influence it.

Test: Compare the composition, structure, and function of managed lands with the natural forest appropriate to the site.

Using horses to log is one practice that allows us to harvest timber with the least possible effect on the natural diversity of the forest. (Photo: Jim Drescher)

Economic principle

Building soil is the only sustainable way to increase the productive capacity of the forest.

Practice: Minimize the removal of trees and other plant material from the site. In order to do this, first reduce the quantity of things you need to buy by substituting on-site resources for imported energy, food, housing, equipment, and so on. Second, to the extent that it is necessary to acquire things from elsewhere, pay for them by selling value-added products; that is, maximize "value-to-biomass ratios."

Test: Measure or estimate the amount and distribution of dead wood on the site; compare this with the natural condition.

Social principle

Care for the welfare of all beings.

Practice: Reduce the impact (costs) and spread the wealth (benefits). First, identify your real needs and resist taking more. Second, increase labour intensity where it can be traded off against capital intensity.

Test: Apply full-cost accounting to measure total costs relative to the benefits for the community.

ECOFORESTRY AND SOCIETY

The ecological and economic principles, practices and tests speak for themselves, but perhaps a bit more needs to be said about ecoforestry and society (including, but not limited to, human communities). The ecoforester makes a commitment to care for the welfare of all beings as intrinsic value. At its root, this means allowing room for others to live their lives, which means minimizing the natural resources one consumes and degrades, one's "ecological footprint" as Bill Rees has called it.

The resources of the Earth are as finite as those of a fresh huckleberry pie. The pie does not expand just because we get hungrier or because more of us arrive at the table. Caring for all other beings requires that we contemplate the consequences of our desires. Living ethically, from the point of view of sustainable society, means reducing our own slice of pie to the thinnest possible wedge. Practically speaking, this means minimizing our disruption of other lives (costs) and encouraging equitable distribution of resources (benefits). Within ecoforestry there are specific management and harvesting practices, as well as product marketing and purchasing practices, that tend to minimize costs and maximize benefits.

It may seem odd to test for social success using an economic indicator, namely, full-cost accounting. However, it is only by "paying as we go" that we can account for the effects of our actions. Alternatively, we could use "full-benefit accounting" just as effectively because as costs are minimized, benefits tends to be maximized and vice versa. It is more than interesting to note that if the entire forestry industry shifted to a genuine system of full-cost/full-benefit accounting, then "profit" would be an accurate measure of "sustainability," thus eliminating a noxious dichotomy of our age.

Windhorse Farm is an experimental place. Financially life is difficult, but it is possible. In most other ways, it is the best living imaginable. (Photo: Jim Drescher)

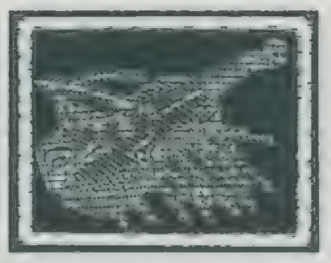
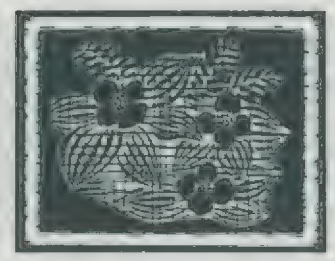
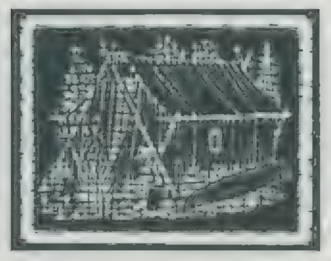
CONCLUSION

So, how's it going at Windhorse Farm? It's hard to say. Things are always changing. This is an experimental place. However, this much we know: the land has provided a good livelihood for a family since 1840; it has provided food and lumber to this community, and employment for local residents, on a continuous basis for that entire time. The standing volume of timber has not diminished.

Is this sustainability? It is too soon to say. This place has been settled for less than one third of the lifetime of one hemlock tree, and just a flicker in the age of a forest. However, the experiment is well underway. We know of no other place where a consistent set of management principles has been applied for this period of time.

Can you make a living at it? Financially it is difficult; but it is possible if we rigourously apply the principles of ecoforestry that this place is teaching us. In most other ways, it is the best living imaginable: natural wealth is abundant.

Other than the natural beauty and richness of the place, what keeps us going with this labour-intensive and somewhat unremunerative venture? Our teachers, human and non-human, have clearly pointed out that a vision for sustainable society, within the context of a sustainable forest, grows out of the experience of our inseparable relationship with all other beings of the forest. That vision is sharpened by scientific and economic realization and then brought down to Earth by the everyday life of working in the woods. The goal is to join the vision of sustainable society with the practicality of ecoforestry, for the benefit of all beings. Our wish is that the experiment at Windhorse Farm may contribute more benefit than cost.

Bringing ecoforestry to the BC Forest Service

Jim Smith

BACKGROUND

British Columbia (BC) has been severely criticized over the years for its forest management practices. Although this criticism has spurred some recent changes in the form of a Forest Practices Code, the majority of timber-cutting operations in the province still follow an industrial approach. One of the few examples of a more holistic approach to forest management is the BC Ministry of Forest's own Small Business Forest Enterprise Program (SBFEP) in Vernon.

SBFEP is a program that auctions standing timber to small logging companies and contractors. Approximately 13% of BC's timber is sold this way. (Of the rest, nearly 85% is controlled by large corporations through long-term tenure agreements with the government.) The small-business program gives the Forest Service a tremendous opportunity to demonstrate innovative forest management.

The changes actually began in 1983 when the Vernon Forest District decided to try some alternatives to clear-cutting to control a mountain pine beetle infestation. I joined the Vernon District staff in 1985. Before that, I had been working on a joint Canada/US project to use partial cutting in an effort to preserve habitat for the Selkirk Caribou herd near Creston, BC. When I arrived in Vernon, the interest in pursuing options was already there; I have been fortunate to work for 11 years as the Small Business Forester for the Vernon Forest District in the Okanagan. Organizations often reflect the philosophy and attitudes of the people working in them. This is certainly the case in the Vernon Forest District. Several key staff members here have a vision of forest management that genuinely considers the whole forest — not just timber.

LOCATION

Vernon is located in south central BC and encompasses a diverse forest ranging from dry ponderosa pine grassland types to wet interior cedar hemlock ecosystems to high elevation subalpine forests of spruce and fir. Our operating areas have a sampling of them all. Non-timber values of the forest include providing community watersheds, important ungulate winter range, grizzly bear and mountain goat habitat, important viewscapes, and plenty of areas for angling, camping, and hiking. We didn't look at non-timber values as problems, but rather as opportunities to demonstrate appropriate forestry. And we had fun doing it!

VERNON LOG SALE PROJECT

In 1993, some fairly large amounts of timber were released from corporate control following a tenure transfer. The Ministry assigned an additional 40,000 cubic metres of forest land in the Vernon District to the SBFEP. Over the next few years, with Ministry approval, we designed and carried out the Vernon Log Sale Project. The Ministry was interested in three objectives:

- to document the practicality of alternative logging methods in use in the District;
- to investigate alternative methods of selling logs; and
- to test the financial viability of both the above projects.

First, identifying the Forest Ecosystem Network

Translating a holistic vision into reality begins with a good plan. We had some of our forestry contractors develop Total Resource Plans for the 38,000 hectares in our operating areas. These plans first identified critical areas that needed preservation or special treatments, and thus old growth areas, major riparian zones, recreation sites, and areas of terrain instability were identified and protected. Critical wildlife habitat was mapped as were movement corridors. These corridors were used to define a Forest Ecosystem Network (FEN), which ensures long-

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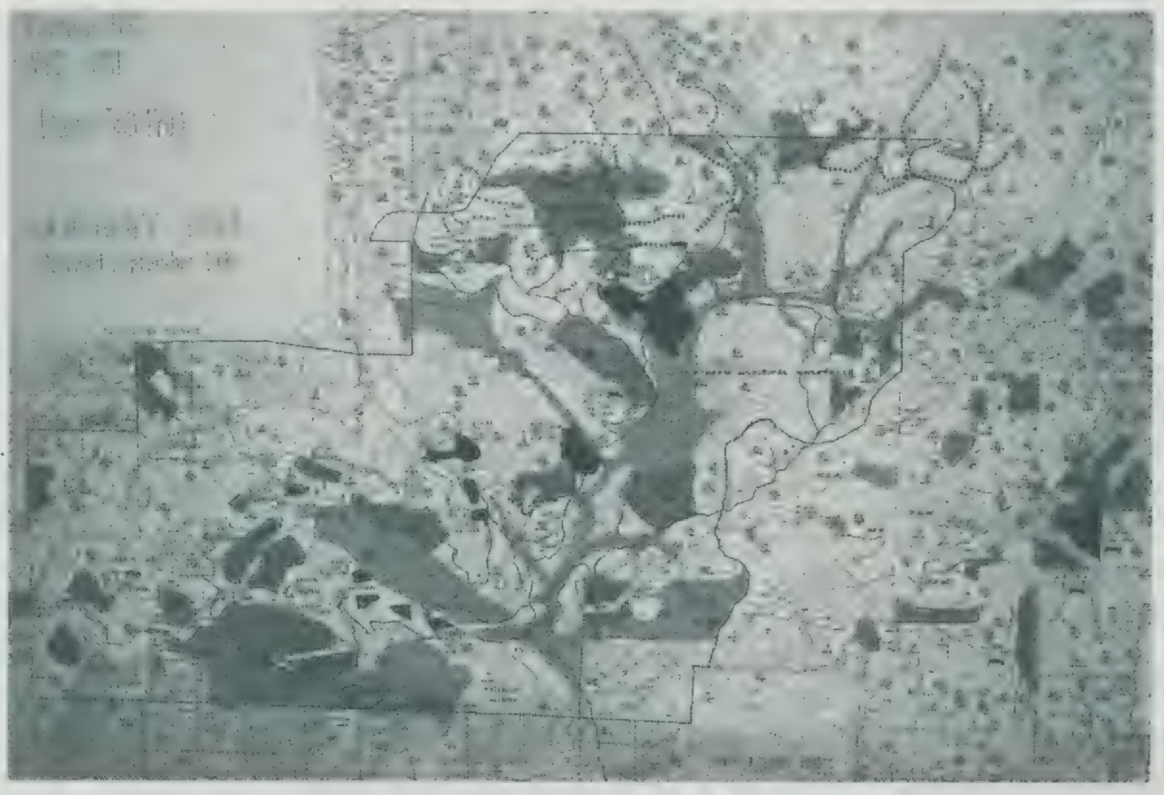
term landscape connectivity for all animals and plants and the protection and/or special treatment of critical values. In short, the FEN serves as the backbone of the plan.



Map of Coldstream showing Forest Ecosystem Network. The blackest areas on the map represent future timber sales, and the lighter shaded areas represent the areas and corridors that have been protected.

Second, harvesting trees responsibly

Next, in the areas we identified as available for harvesting (about 70% of the total area), we planned cutblocks and road networks and scheduled appropriate silvicultural systems and harvesting methods. As often as possible, we used silvicultural systems that protected or enhanced the values in the forest, such as shelterwood, group selection, or single tree selection systems, and we established a policy of "taking the worst and leaving the best." We applied these methods to 65–70% of the area we harvested or planned for harvesting.

Third, selling our product

The idea of selling the logs that we harvested through an SBFEP log yard had its roots in the Forest Resource Commission's report tabled in 1990. At that time, the commissioners recommended diversifying the forest economy of the province by creating log markets. In BC, logs are not normally available for purchase by species and grade or in small quantities. Because we do not have a truly competitive log market, the provincial government (and thus, society) captures only a fraction of the value of timber that is cut. We proposed to test the concept of an open log market for some of the 160,000 m^3 we cut annually, and have since demonstrated that a small competitive log market generates about four times the gross revenue as current industry-government tenure models. Costs are higher due to the greater intensity of labour at all phases — i.e. scaling 100% of the logs, sorting products, slower and more careful logging. The average stumpage revenue from large companies is around \$25/m^3, whereas our net revenue is between \$50 and \$60/m^3.

The log yard has been running for four years now with great success. Manager Tom Milne has done an excellent job of responding to customers' requests for log sorts; he now sells about 48 different products. Traditional products such as sawlogs and peelers make up about 70% of the Vernon Log Yard sales; these are bought by a variety of mills, both large and small. The other sales are specialty items such as house building logs, guitar blank wood, and oversized logs. These are usually bought by small value-added woodworking firms and individuals. The beauty of the log yard is that anyone can buy logs in any quantity. The yard sells approximately 2,000 m^3 of logs a week from July to March, for a total of 55,000 m^3 per year.

Achievements and advantages

The log yard has many advantages for both customers and the government. All costs and revenues are actual

Certified sale after logging has removed 30% of the timber by taking the worst and leaving the best. This is the initial entry of a three-phase shelterwood. (Photo: Jim Smith)

Jim Smith (left), Susan Hammond, Herb Hammond, and Tom Milne by a deck of Canada's first certified logs. (Photo: Jim Smith)

competitive figures and have given the government a good look at the economics of partial cutting. The Vernon project has shown that alternative silviculture systems and an open log yard are profitable and practical. For years, the timber industry has been telling the government that these systems were not economically feasible. It should know better now!

Partial cutting and open log sales also provide significantly more job opportunities per volume of wood cut for everyone involved — foresters, loggers, truckers, scalers, log yard operators, and value-added woodworkers who can finally get wood. The big advantage for me as a forester, though, is the ability to use forestry techniques that have strong public support.

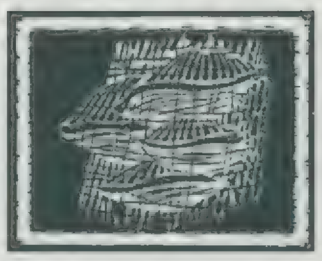
In late 1994, Herb Hammond of the Silva Forest Foundation (SFF) contacted me about certifying some of our timber management areas as ecologically sustainable. SFF had developed a set of criteria similar to those of the Forest Stewardship Council, a worldwide certification organization. After looking at a number of our proposed silviculture prescriptions, Herb decided to have a close look at three logging blocks. One block was certified in October 1995; the logs from that block going to our log yard are tagged with SFF's Eco-Cert mark as certified wood. This was Canada's first certified timber and we are very proud of it.

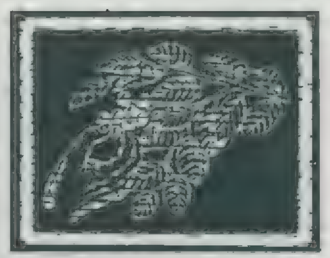
CONCLUSION

Over the years, people from all over the world have visited our forests to see the gentle management practices and procedures in the log yard. We've also received dozens of letters from people expressing their support for this kind of forestry and the economic opportunities it provides. In BC, that is a major change in the public's response to forest management!

On 19 June 1996 I was showing about 50 industry and Forest Service "communicators" (public relations people) an area of Douglas fir that had been partially cut in the fall of 1994. We had logged about 30% of the stand volume in our usual mode of "take the worst and leave the best." After a short discussion, it became clear that most of the industry folks were not in favour of that kind of logging. As we were walking through the lush herbaceous growth on our way back to the bus, a couple of the people accused me of showing them a stand that hadn't actually been logged. They couldn't see any stumps! After showing them several fresh stumps hidden by the pathfinder and arnica, I said, "You know, that's the best compliment I've ever had for our forestry practices."

Forest Service scaler John Parks with a "musical intrument" spruce log used for guitars.
(Photo: Jim Smith)





Forests, indigenous peoples, and biodiversity

Russel Lawrence Barsh

This paper was specially edited for *Global biodiversity* from a submission prepared on behalf of Four Directions Council, an organization of North American indigenous peoples, on the invitation of the Secretariat of the Convention on Biological Diversity. The original submission is reflected in the Secretariat's report, *Indigenous and Local Communities and Forests* (Montreal, January 1996).

To understand the contributions that indigenous peoples can make to conserving biodiversity, particularly in forests, it is useful to begin with some general aspects of the epistemology, conceptual structure, and customary law of indigenous peoples' traditional knowledge. This review is based upon experience and community-level research in North America — chiefly in Canada's Atlantic and Pacific coastal regions — as well as discussions with scholars and leaders from other indigenous communities on this continent and other regions.

NATURE OF INDIGENOUS KNOWLEDGE

The traditional ecological knowledge (TEK) of indigenous and tribal peoples is *scientific* in that it is empirical, experimental, and systematic. However, it differs in two respects from Western science.

First, TEK is highly localized. Its focus is the complex web of relationships between humans, animals, plants, natural forces, spirits, and land forms *within a particular locality or territory*. Therefore, although reluctant to generalize beyond their own field of observations and experience, indigenous peoples can make better predictions about the consequence of physical changes or stresses within a particular ecosystem than scientists who base their forecasts on generalized models and field observations of relatively short duration, often restricted to the university-break season.

Second, the localization of TEK has important *social* and *legal* dimensions. Every ecosystem is conceptualized as a web of *social relationships* between a specific group of people (family, clan, or tribe) and the other species with which they share a particular place. Ecological models often appear in stories of marriages or alliances among species. Hence the structure of an ecosystem is regarded as a *negotiated* order in which all species are bound together by kinship and solidarity.

Legal Aspects of TEK

This social conception of ecology has five main legal corollaries, which must be respected in any framework for the protection of indigenous peoples' intellectual property rights (IPR):

One. Every individual human and non-human in the ecosystem bears a personal responsibility for understanding and maintaining their relationships. Knowledge of the ecosystem is moral and legal knowledge, and adepts are not only expected to teach their insights to others, but to mediate conflicts between humans and other species.

Two. Since knowledge confers heavy responsibilities, as well as the power to interfere with relationships between humans and non-humans, it must be transmitted personally to an individual apprentice who has been properly prepared to accept the burdens, and to use the power with humility. Teaching is preceded by the moral development of the pupil, and tests of the pupil's courage, maturity, and sincerity.

Three. Knowledge is ordinarily transmitted between kin because it pertains to inherited responsibilities to their own ancestral territory. Since knowledge is localized, it is not necessarily applicable to other ecosystems. Moreover, it could be dangerous for outsiders to obtain information that could be used to meddle with what is regarded as the internal affairs of the local human and non-human "extended family."

Four. Knowlege may sometimes be shared with visitors to the territory so that they can travel safely and subsist from local resources, but knowledge cannot be alienated permanently from the ecosystem to which it pertains. Knowledge can only be *lent* for a specified time and purpose, generally in exchange for reciprocal

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loans of knowledge by the borrowers. Lenders retain the right to terminate the loan if the knowledge lent is misused, or if the responsibilities attached to its use are not fulfilled.

Five. Misuse of knowledge can be catastrophic, not only for the individual who abuses it but for the people, the territory, and (potentially) the world. Misuse of knowledge is tantamount to an act of war on other species, breaking their covenants, and returning the land to a pre-moral and pre-legal vacuum. This is the reason that indigenous peoples tend to take a "precautionary" approach to the use of ecosystems. Any human activity that goes beyond the bounds of *known relationships* among species involves a risk of triggering retaliation and chaos.

Consistent with these general principles, indigenous peoples possess their own locally specific systems of jurisprudence with respect to the classification of knowledge, proper procedures for acquiring and sharing knowledge, and the nature of the rights and responsibilities that are attached to possessing knowledge. Some categories of knowledge may be attached to individual specialists, and other categories of knowledge to families, clans, or the tribe or nation as a whole. In most societies, knowledge is also divided by gender; women are most often the bearers of botanical and medicinal knowledge.

The complexity of local laws governing the distribution of knowledge has important *political* implications, because no one, and no family or clan, can possess sufficient knowledge to act alone. Decision-making requires the sharing of knowledge, hence a balancing of all interests, including the concerns of non-humans. One clan may speak for its kinfolk the otters, to whom they owe special knowledge and powers, while another clan speaks for the foxes or the trees.

This diversity of intellectual property arrangements is a result of culturally different responses to ecological diversity. Indigenous peoples are consequently opposed to the adoption of a universal definition of "traditional knowledge," and would prefer that the international community agree that traditional knowledge must be acquired and used *in conformity with the customary laws of the peoples concerned.*

Indigenous peoples also feel that their approach to sharing knowledge is incompatible with the "commodification" of the arts and scientific discoveries in contemporary intellectual property law. Intellectual property law has two objectives:

- to encourage *innovation* by providing the innovator with monopoly control of the commercial applications; and
- to encourage the *diffusion* of technology by limiting the duration of the innovator's monopoly.

Among indigenous peoples higher priority is given to the *proper use* of knowledge locally, rather than accelerating growth in the total *quantity* of knowledge globally.

Temperate cordilleran forest, North Cascades, Washington State (Chelan-Okanagan territory). (Photo: R. Barsh)

TEK incorporates individual innovation

Indigenous peoples are not indifferent to the importance of innovation, however. Indigenous cosmologies portray a universe in continuous flux, driven by known forces as well as a diversity of powerful random elements ("tricksters"). Everything is bound eventually to change in ways that cannot be forecast accurately, hence the need for humans to remain vigilant and adaptive.

The use of the term "traditional" implies the repetition, from generation to generation, of a fixed body of data, or the gradual, unsystematic accumulation of new data. On the contrary, each generation of indigenous people makes observations, compares their personal experiences with what they have been told by their teachers, conducts experiments to test the reliability of their knowledge, and exchanges their findings. All "tradition," in actuality, is continually undergoing revision.

Each individual must be a scientist in order to survive as a hunter, fisher, forager, or farmer with minimal mechanical technology. And so each individual is necessarily engaged in a lifelong personal search for ecological understanding; moreover, the standard of "truth" in indigenous knowledge systems is direct personal experience. Indigenous people are suspicious of second-hand claims (which form the bulk of Western scholars' knowledge), but at the same time they are reluctant to challenge the validity of anyone's own observations.

Thus what is "traditional" about traditional knowledge is not its antiquity, but *the way in which it is acquired and used,* which in turn is unique to each indigenous culture. Much of this knowledge is actually quite new, but it has a social meaning and legal character, entirely unlike the knowledge indigenous peoples acquire from settlers and industrialized societies. This is why indigenous leaders believe that protecting indigenous knowledge effectively requires the recognition of each people's own laws, including their own local processes of discovery and teaching.

Mesquite forest, Colorado River floodplain, Arizona (Mohave territory). (Photo: R. Barsh)

TRADITIONAL LIFESTYLES PROTECT BIODIVERSITY

There are at least four main reasons the continued use and management of an ecosystem by indigenous peoples is important for conserving biological diversity.

First, indigenous peoples' traditional economic systems have a relatively low impact on biological diversity because they tend to utilize a great diversity of species, harvesting small numbers of each of them. This has little or no effect on intra-specific population dynamics or on inter-specific niche competition. By comparison, settlers of the past targeted far fewer species and collected them or bred them in vast numbers, changing the structure of ecosystems. Today's commercial harvesters are no different. The Blackfoot, for example, were eclectic harvesters of elk, deer, bison, antelope, wild sheep and goats, and a great variety of rodents and waterfowl. Settlers targetted the largest mammal — bison — and exterminated this species within 20 years. Settlers then replaced the entire community of wild native herbivores with cattle, and replanted the botanically diverse prairies with two species of European forage grasses.

Second, indigenous peoples try to *increase* the biological diversity of the territories in which they live, as a strategy for increasing the variety of resources at their disposal and, in particular, reducing the risk associated with fluctuations in the abundance of individual species. Since each species is subject to different limitations and its abundance varies in response to somewhat different factors, an increase in the variety of niches and species tends to stabilize the average year-round supply of food and materials.

Indigenous peoples' traditional territories are therefore *shaped environments,* with biodiversity as a primary management goal. The modifications may be subtle, however, and can easily be confused with the natural evolution of the landscape. For instance, indigenous peoples typically burn "yards and corridors" in forests to create islands of fresh regrowth and increase edge effects. Berries and medicinal herbs are particularly abundant in the early successional stages of forest recovery from fire. Islands and edges also attract large mammals. Periodic firing also prevents the forest as a whole from becoming dominated by a very small number of tree species.

Early settlers assumed that the "park-like" architecture of North American temperate forests — and the relative treelessness of the north-central plains — were natural phenomena. Soon after indigenous hunters and horticulturalists were displaced from the eastern woodlands, the open-textured temperate broadleaf forests first seen by settlers had filled in and became more oligarchic.

Third, indigenous peoples customarily leave a large "margin for error" in their seasonal forecasts of the abundance of plants and animals. By underestimating the harvestable surplus of each target species, they minimize the risk of compromising their food supplies. Unfortunately, this management practice often led settlers to conclude that indigenous peoples had an abundance of land and resources to spare. Hunting, logging, and clearing by settlers quickly forced indigenous peoples themselves to harvest whatever remained in order to survive (often leading, ironically, to arguments that they were wasteful).

Fourth, since indigenous knowledge of ecosystems is learned and updated through direct observations on the land, removing the people from the land breaks the generation-to-generation cycle of empirical study. Deprived of routine direct interaction with the ecosystem, indigenous peoples lose the means of transmitting old models and data, as well as the means of acquiring new knowledge. Basic concepts may survive, but lose their concrete applications. What remains can be as abstract as Western theories of ecological dynamics. Maintaining the full empirical richness and detail of traditional knowledge depends upon continued use of the land as a classroom and laboratory.

EROSION OF INDIGENOUS KNOWLEDGE

In North America, forest-related knowledge is in imminent danger of being lost — despite the fact that Canada and the United States have taken steps since the 1970s to resolve land claims, increase indigenous communities' control of the forests on their remaining lands, and consult with indigenous peoples in the management of public lands.

Why? First, as already mentioned, traditional knowledge is taught through a combination of practical experiences and words. There has been a marked decline in the proportion of indigenous children who speak indigenous languages due to the residential-school policy, compulsory public education in English or French, and the influence of television. Many indigenous communities in Canada have witnessed a decline in native-language use of 50% or more in the past 20 years alone. Moreover, the children who continue to speak indigenous languages rarely learn the full technical vocabulary of their elders. It is common to hear young people say: "my grandfather uses big words I don't understand." Unfortunately, those "big words" include scientific terms needed to explain ecological processes.

Compulsory public education and television have also had the effect of keeping children indoors, spending little time in the bush with their older kinfolk engaged in traditional activities such as hunting, fishing, foraging, or gathering medicinal plants and plant materials. In many communities, furthermore, there is simply nowhere left to conduct these activities. The land has been taken for development or environmentally degradated. Conservation laws restricting the harvesting of wildlife and plants also limit the opportunities of indigenous children to experience ecosystems first-hand. Influenced by television and advertising, a growing number of indigenous children regard traditional activities and foods as primitive, dirty, unnecessary hardships associated with poverty and isolation. They may feel ashamed to spend time with elders who speak little English and work in the forest instead of in an office.

As indigenous children learn less of their own languages and spend less time in traditional activities, indigenous communities turn increasingly to universities for technical expertise in land management. Faculties of forestry rarely acknowledge traditional knowledge or management practices, and often continue to promote maximum wood production as a management goal. Indigenous youth who pursue university training in forestry are inculcated with a perspective that is largely incompatible with their own peoples' knowledge systems and values, and this discourages them from seeking advice from their own elders. As a result, relatively abstract Western conceptions of forest dynamics are gradually replacing richly detailed, locally specific knowledge *within* indigenous communities themselves.

CONCLUSION

Traditional lifestyles are sustainable and compatible with the preservation of biodiversity as long as indigenous peoples are not forced to abandon their customary management practices in response to dispossession, intrusions by settlers, or degradation of the ecosystems upon which they depend for their subsistence. The maintenance of sustainable traditional lifestyles, therefore, depends on respect for indigenous peoples' right to the *exclusive use and management* of their territories.

If empowered to maintain and develop their own forests and forest-related knowledge, indigenous communities will undoubtedly share a large part of their ecological and medical sciences with other societies. Generosity and reciprocity are core values of indigenous cultures. The determination of what may properly be shared, the means by which it may be shared, and the recompense that may justly be demanded, should nevertheless be left to each indigenous people. The imposition of rules defining or limiting indigenous peoples' claims to their own scientific heritage will be counterproductive. It will result in communities' refusal to reveal what they know, or to deliberately distort information — as anthropologists have long realized.

Even if indigenous peoples' right to share their knowledge on their own terms is formally recognized, the extent to which they share equitably in the commercial value of their knowledge will depend on: (1) the degree to which they are fully informed about the potential value of their knowledge, and about the legal consequences of any agreements they may make with outsiders; (2) the extent to which they possess the institutional capacity, at the community level, to engage in effective negotiations, as well as the financial resources to take legal action when necessary to enforce their rights; and (3) the extent to which effective and affordable legal remedies exist at the national and international levels.

In most countries, indigenous communities do not even enjoy legal "standing" under domestic law. They cannot institute legal proceedings in their collective capacity, or on behalf of their constituent families and clans. In most national legal systems, moreover, traditional knowledge is not recognized as "property" that can be defended or recovered through private legal actions.

Traditional knowledge also falls outside of the definitions of intellectual property used by existing international treaties on patents, copyright, and trade law. Even if some governments adopt legislation to give their indigenous peoples special legal protection, other governments will not be bound by international law to respect those laws. Lack of international enforceability is a serious weakness: traditional knowledge is most likely to be exploited commercially by powerful transnational corporations in fields such as biomedicine and biotechnology.

There is a need for the international community to agree that indigenous peoples are the true owners of their ecological knowledge, and that disputes over rights to the acquisition and commercial application of indigenous sciences must be resolved in accordance with indigenous peoples' own laws. Governments, the scientific community, and universities should also contribute to ensuring that indigenous peoples themselves possess information, training, and institutional structures of their own — sufficient to evaluate external research, negotiate collaborative agreements with outside researchers, and if necessary, take private legal action to prevent the licensing or sale of knowledge that was not properly acquired from them.

Taking these steps would help reverse the recent erosion of indigenous knowledge systems, and make it possible for indigenous peoples to begin making their own unique scientific contributions to stabilizing and sustainably utilizing the world's forests.

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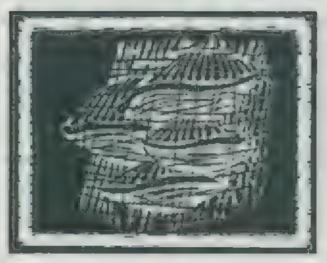
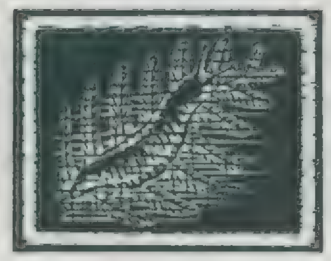
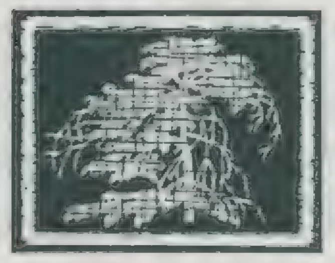

Threats to woodland caribou and the taiga

William O. Pruitt, Jr.

INTRODUCTION

Today the woodland caribou *(Rangifer tarandus caribou)* is in trouble, as is the whole boreal forest ecosystem in which it lives. I have a particular affection for *R. tarandus* because I realize that my own Cro-Magnon ancestors depended on them for meat, skins, bones, and antlers. In some archaeological deposits in France and Spain, 100% of the animal material is caribou, and the people who depended on them recorded their behavioural and anatomical observations with carvings and in charcoal and ochre mixed with caribou fat on the walls of stone in Dordogne, Bruniquel, Arudy, and other European sites (Pruitt and Pepper 1986). Woodland caribou are "our animal" and, if for no other reason, merit our love and care.

We have certainly not repaid them with love and care, but with persecution and theft of habitat. To compound the situation, we know ridiculously little about them or how our actions are affecting them. Even though more scientific papers have been written about *R. tarandus* than any other Canadian mammal, almost all of them concern barren-ground caribou (*R. t. groenlandicus*) — which I prefer to call tundra caribou or snow caribou — the subspecies that performs the spectacular migrations of over 1,000 kilometres a year.

Woodland caribou, in contrast to tundra caribou, are bigger, darker, with heavier antlers, and even bigger hooves. They live in small groups that are either sedentary or perform only local movements. Because they are so

This paper has been adapted and updated from a paper originally given at Conservation of Northern Forests, a conference at the University of Toronto in late 1995.

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scattered and secretive, even estimates of total or regional numbers vary widely. They are subject to fires, logging, poaching, legal hunting by Treaty Indians, forest clearing for agriculture and grazing (Pruitt 1995), as well as unregulated tourist interference. Very few Canadians have ever seen a woodland caribou; most people have never even heard of them. We could lose them tomorrow and nobody would be the wiser. How many people know that we have already lost the Dawson caribou, an endemic subspecies of woodland caribou, that was found on the Queen Charlotte Islands in British Columbia?

This paper focuses on the different threats that the woodland caribou face in 1997 and illustrates that in order to preserve this species, Canadians must preserve the boreal forest, or as it is technically known — the taiga. It is one of the most fragile forest ecosystems in the world. In turn, this paper shows that the taiga is more important as a carbon sink than as a source of trees for commercial returns.

WOODLAND CARIBOU: HABITAT DISTURBANCE

Although seasonal usage patterns differ from region to region, all woodland caribou use both arboreal lichens and forest-floor lichens as a major source of food. Therefore, the most important disturbances to the habitat of the woodland caribou are those that affect the lichens — wildfire and clear-cutting.

Wildfire

Wildfire has occurred sporadically in the taiga ever since glaciation, but with a frequency of 100 years or more (Stardom 1977; Schaefer and Pruitt 1991; Payette 1992). There are many records of buried layers of charcoal in soils of the taiga. Short-term drought was probably the major factor controlling ultimate frequency of wildfire in pre-human times, with lightning the proximal cause.

Humans have been in North America in association with the woodland caribou for about 30,000 years (Kurtén and Anderson 1980). Wildfire set by aboriginal people was probably sporadic, set mainly to provide relief from annoying insects and to improve habitat for moose *(Alces alces)* (Lewis 1982; Lewis and Ferguson 1988; Pyne 1982). The fires could be extensive, however (Stefansson 1951), and were probably eventually controlled only by weather. There is wide variation in number, size, severity, and geographic location of fires in woodland caribou habitat. In general, human-caused fires are more common closer to habitations and are, therefore, fought and remain smaller. Lightning-caused fires are usually far distant and are, therefore, allowed to "burn themselves out" naturally.

Obviously, wildfire destroys woodland caribou habitat. In 1991, Jim Schaefer and I described the effects of a 1980 fire on woodland caribou near the Taiga Biological Station in southeastern Manitoba. We discovered that as the vegetation began to recover from this extensive and severe fire, there was enhanced production of summer forage, but reduced quality of and accessibility to winter forage. We found that winter range and forage were critical to woodland caribou. Not only was there loss of lichens, both terrestrial and aboreal, but loss of the forest canopy allowed wind and sunshine to change the thickness and hardness of the snow cover (Pruitt 1989; Schaefer and Pruitt 1991; Stardom 1975; 1977). Terrestrial lichens can be expected to recover to biomass densities useful to woodland caribou in about 50 years, but due to the changes in species and size of trees, the snow characteristics will remain adverse for 80 years or more. In contrast, stable-age stands ("old growth," 160 years old) show reduced lichen crops accessible by caribou, but more favourable snow conditions (Schaefer 1996).

The woodland caribou showed remarkable fidelity to the pre-fire range for 5.5 years after the fire (Schaefer and Pruitt 1991). By this time, the roots of the fire-killed trees had rotted so that the entire fire-affected landscape became rather suddenly a jack-straw tangle of downed trunks. At this time the caribou abandoned their traditional trails and routes. They still invaded the general region of their traditional wintering grounds by wending their way along connected open or unburned bogs, but they would not cross even relatively narrow burned ridges with the tangle of downed trunks. We should note here that fire-ravaged areas are quite different from clear-cut areas (Ball and Walker 1997). Not only are size and shape different, but the residue is different. Needles, twigs, and branches are burned and most trunks remain standing. In a clear-cut the needles, twigs, and branches remain but the trunks are carried away.

Every fire is different, depending on topography, vegetation types, soil and duff moisture, winds, and other factors. Therefore, the results of fire differ. Some fires result in the loss of only half the total area (LeResche et al 1974). Other fires are far more severe. For instance, the 1980 fire near the Taiga Biological Station encompassed 600 km^2 of woodland caribou range, but about 7 km^2 of terrestrial lichen cover remained.

Logging

Aboriginal timber cutting was mainly for fuelwood (Pyne 1982; Turner et al 1990), done only in small areas, and was sporadic and incremental. It was probably of very little or no consequence to the survival of woodland caribou. Similarly, removal of forest cover by early European settlers was primarily for fuelwood (Turner et al 1990). Only later did the "invaders" begin consciously removing forest cover as a result of governmental policies or in response to economic pressure from outside the local region. For example, to provide masts for the British Royal Navy during the Napoleonic wars, the forests of eastern Canada were stripped of their huge white pines. Fortunately for the boreal forest and the woodland caribou, this widespread cutting did not reach very far north.

In the last 20 or 30 years, the fury of the modern industrial logging practice of clear-cutting has hit woodland caribou habitat. The effects have been disastrous (Cumming 1992; 1997; Cumming and Beange 1993; Darby and Duquette 1986; Edmonds and Bloomfield 1984; Racey et al 1991; Stevenson 1986). Indeed, Edmonds and Bloomfield (1984) reported that woodland caribou in Alberta did not feed in clear-cuts larger than two hectares and were known to cross a larger clear-cut only once in four years. Whether the proximate cause(s) of decline in caribou numbers are the disappearance of the food base or predation resulting from increased populations of moose or disease resulting from increased populations of white-tail deer (Anderson and Strelive 1968), the ultimate cause is the loss of stable-aged taiga due to clear-cutting (Cumming 1997). The resulting shrinkage of caribou habitat has meant a decline in numbers. For example, the local population of woodland caribou around the Taiga Biological Station has steadily declined. In 1968, there were 46 animals counted. Since 1987 there have been no more than 12 individuals seen (Hill 1979; Darby 1979; L.A. Decker, unpublished data; Schaefer and Pruitt 1991; Stardom 1977; unpublished files at Taiga Biological Station).

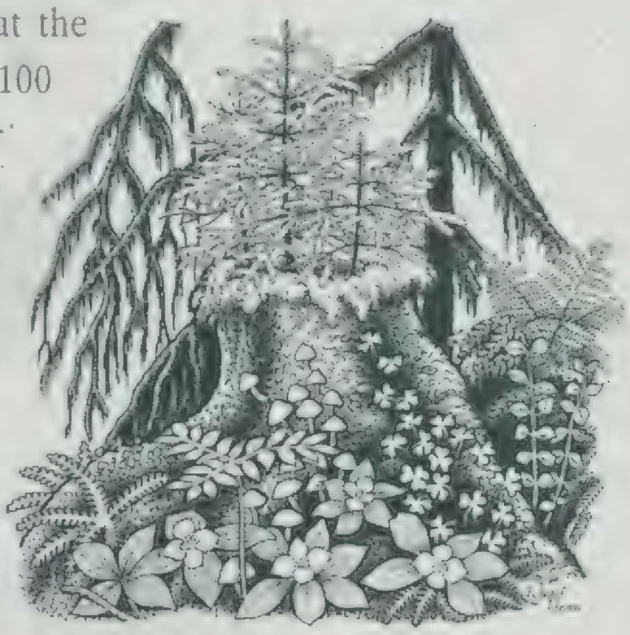
Loss of habitat continues. For example, even though woodland caribou are designated "endangered" in Alberta, the provincial government is allowing the clear-cutting of the residual winter range of the largest remaining herd (400 to 500 animals) near Prairie Creek (560 km^2) and Redrock Creek (900 km^2) (CPAWS 1995). These two basins, and the caribou that winter there, are entirely within a Forest Management Area (FMA) of Weyerhauser Canada. Between 1985 and 1995 total caribou habitat there has declined from 60% to 30% because of logging and, also, oil and gas activities. Here in Manitoba, Pine Falls Paper Company is pushing an all-weather road up the east side of Lake Winnipeg through a well-known area of woodland caribou winter range. The provincial Department of Natural Resources states there are no caribou in the area!

Moreover, forest succession after clear-cutting may not result in recovery of woodland caribou habitat (Youngblood and Titus 1996; MacLelland *in* Scott 1995). Darby and Duquette (1986) noted:

> Clear-cut logging alters caribou habitat in more ways than simple reversion to an early successional stage unfavourable to the slow-growing lichens. Stand conversion from coniferous to deciduous species may occur, especially where poplar (*Populus* spp.) are common. This is due to rapid vegetational reproduction of deciduous trees and shrubs. Lichens, fungi and some ericoids are replaced by vasculars. Woody browse proliferates, benefitting moose *(Alces alces)* in winter but not caribou.

THE LAW OF THE MINIMUM

The ecological "Law of the Minimum" helps us understand the problem of habitat disturbance and the woodland caribou. Simply put, the law means that the part of the ecosystem in shortest supply limits the total mass of living material that the habitat can support, even if 99 of 100 categories are present in super abundance. Often considerable research is needed to discover the limiting factor for each species and/or each habitat. Otherwise efforts to increase one species by furnishing extra food may be useless if cover or shelter, for example, are in short supply.

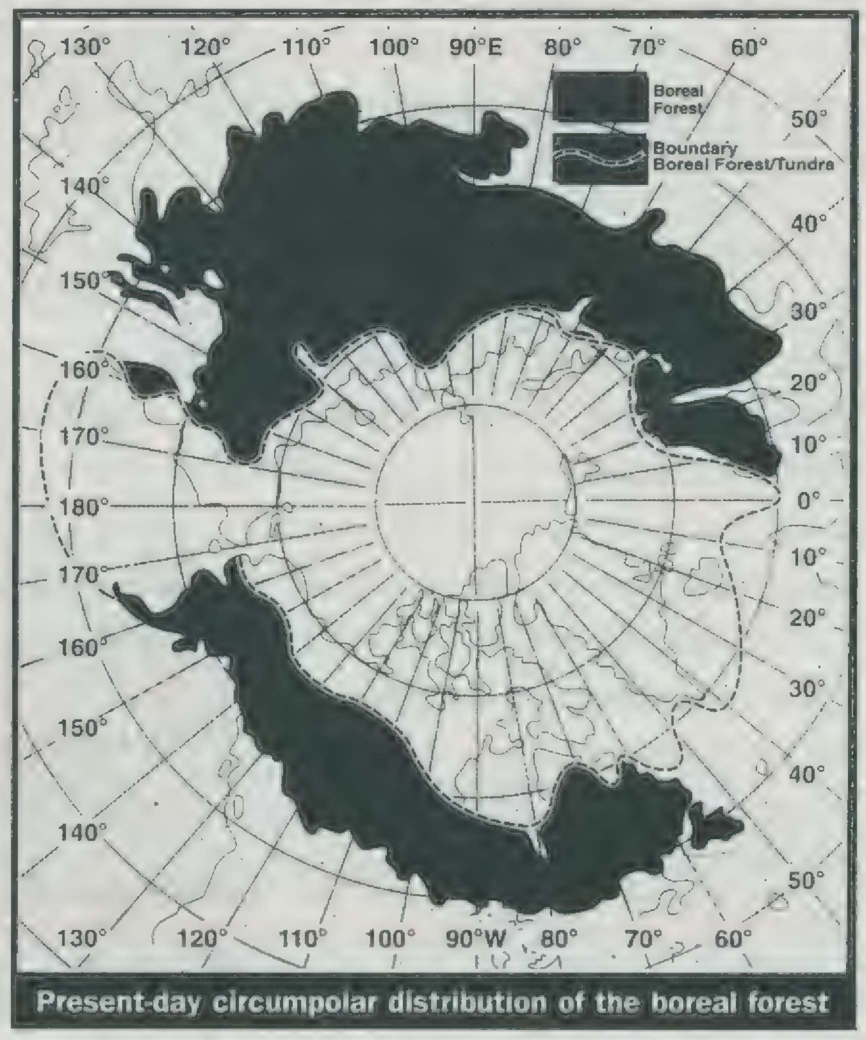


It is also important to understand the associated concept of the "carrying capacity" of a habitat — i.e. how many animals (or people, for that matter!) can survive in accordance with the resource in shortest supply *per unit* of habitat. Assume that a taiga region has a mix of different-aged forest stands. The proportions of young, middle-aged (or age-specific), and stable-aged (so-called "old growth") stands are sufficient in size and proximity to offer suitable habitat in all seasons and all variations of snow cover morphology to X number of woodland caribou. If half of this region is burned or clear-cut, then no more than half of X woodland caribou can survive. The remainder cannot simply "move out" and still survive. Usually habitats are saturated with organisms; that is, no more individuals can exist there than already do so and there is nowhere to go. Deer are not "displaced" by a dam; caribou are not "displaced" by a clear-cut or burn; these individuals are now surplus and they are doomed just as surely as if they were shot.

From this we can draw two conclusions:

1) woodland caribou and present day commercial exploitation of the taiga are not compatible; and
2) mitigation does not appear possible because industry seems committed to clear-cutting and government supports this practice.

Indeed, wildlife managers, locked into the structure of FMAs, do not even consider alternatives such as reducing the amount of wood extracted, selective or partial cutting, or changing the tax structure to allow more benign exploitation such as horse-logging instead of big-machine logging.



Present-day circumpolar distribution of the boreal forest

Source: The Carbon Bomb. Climate change and the fate of the Northern Boreal Forests. 1994. Greenpeace International. Amsterdam, the Netherlands.

PRESERVING THE TAIGA AS A CARBON SINK

In addition to its role as habitat for woodland caribou, the taiga also performs another valuable function for the world: it stores carbon, about 0.35 kg m^{-2}. This function is extremely important in terms of climate moderation. By extrapolating this fact we know that the carbon locked up in the living plants of all of the taiga totals 84×10^9 tonnes (84 giga-tons) (Olson et al 1983).

When the forest is clear-cut, most of the stored carbon begins to be released into the atmosphere. As well, there is a dramatic change in the forest microclimate (Pruitt 1953): increase in temperature, decrease in moisture, increase in the extremes of soil temperature, increase in wind, and degradation of permafrost. There is loss of vegetation on the forest floor, especially lichens, and of course, total loss of arboreal lichens (Bolin et al 1986; Kauppi and Posch 1989). Needless to say, all of this has an impact on the woodland caribou. But it also has an impact on us. Most people agree that the use of fossil fuels is one of the major sources of atmospheric carbon. Most do not realize that about half of the atmospheric carbon since 1860 has resulted from forest clearing — with possibly 10% resulting from the almost explosive clearing of virgin soils between 1860 and 1890 alone (Wilson 1978).

The cutting rotation of the taiga varies greatly, and is based on the economics of pulping — i.e for maximum monetary return, re-cut just at the end of the period of maximum fibre production. In Finland this period is supposed to be 30 to 40 years; in Manitoba in the southern portion of the central taiga, it is supposed to be 40 to 50 years; in interior Alaska it is 120 or more years. In contrast, independent botanists believe that a logged section of taiga needs at least 80 years to restore the pre clear-cut store of carbon. A clear-cut, then, never has a chance to recover comple-tely its store of carbon (Krankina and Harmon, 1994). The magnitude of loss of the taiga is staggering. For example, in far eastern Siberia alone about 300,000 hectares are lost to fires and 280,000 hectares lost to clear-cutting annually (Japan Environmental Exchange 1994).

The taiga also has many peat bogs, and some bogs have been acting as carbon sinks ever since the glaciers receded. One of the consequences of industrial forestry practices is that the bogs and wetlands in the taiga are being drained. As they drain, carbon is released into the atmosphere at a rate of about 10 tonnes/hectare. A total of 15 to 20 × 10^7 hectares of bog in taiga regions have already been drained. Even this amount means that the drained bogs already give off more atmospheric carbon than the remaining bogs can absorb (Billings et al 1982; Gorham 1991; Sivola et al 1985; Sivola and Hanski 1979; Perry et al 1991). It is clear that bog drainage must not only stop but the myriad existing drainage ditches must be plugged and the bogs allowed to resume their vital role as carbon sinks. Likewise the taiga, because of its slow growth, is more valuable to the world as a carbon sink than as a source of dimension lumber and pulp (Isomäki 1990; Larsen 1980).

FUTURE OF THE TAIGA...AND WOODLAND CARIBOU

Projections of future greenhouse-dominated climates postulate that the taiga will undergo more changes than any other forest type, possibly a reduction in area by one third and a pole-ward shift in boundaries. In Canada the taiga has a continent-wide zonal expanse, a pattern that is the result of about 10,000 years of development of soils and shuffling of plant and animal species and communities. Based on the doubling of atmospheric carbon, predictions of vegetation zones show loss of most of the taiga with only isolated remnants remaining.

These new distributions of plants and animals cannot happen in the short time predicted for the basic climate changes. Tree species move slowly, on the order of 300 metres per year (Pielou, 1991); animals can move faster but no faster (and survive) than their habitats can move. The southern boundary of the taiga can move northward rather swiftly because of replacement of trees by grasslands, and the sequence of this movement would likely be as follows: severe and prolonged drought, extensive insect outbreaks on the drought-stressed trees, massive forest fires, and then, invasion by grassland plants that would prevent forest recovery. The northern boundary, on the other hand, can only move very slowly because tundra soils are thin, rocky, acidic, and unsuited to tree growth. Moreover, trees are genetically specialized to the latitude/photoperiod of their site. Movement of a species northward is thus limited by the speed of genetic change through natural selection (Vaartaja 1954, 1959). Changes in vegetation would undoubtedly be accompanied by great changes in animal distribution (Pruitt 1993). Given the precarious nature of the woodland caribou's relationship to its habitat, they appear doomed.

Is the boreal forest the world's best source of timber or is it best left alone to perform its valuable role as a carbon sink?

RECOMMENDATIONS

First, I propose that the world use tropical and subtropical forest land as its sources for lumber, pulp, and other products. One could begin by replanting forests on land cleared for cattle pastures. A tropical rainforest stores only 0.28 kg m^{-2} of carbon (Olson et al 1983;

Powers and Van Cleve 1991; Zinke et al 1984) in comparison to the 0.35 kg m^{-2} of carbon stored by the taiga. In addition, trees grow much more quickly in tropical climates (e.g. in Guatemala one can grow a saw log in 15 years!) and thus, shorter cutting rotations are possible. There is, therefore, greater flexibility to meet changes in demand. Responsible forestry management, of course, needs to be applied to tropical forests with attention paid to preserving ecosystem and species biodiversity, and the human communities that live therein. Several examples exist of successful co-management of tropical forests by native peoples (Myers 1988; Sedjo 1989) and these should be the models of a new forestry style of management in the South.

Second, I propose that the world preserve the boreal forests as a carbon sink. In fact, we should be planting new trees to sequester the new atmospheric carbon that is being released all the time. For example, in order for Manitoba to sequester its share of atmospheric carbon, it should immediately plant 560,000 hectares of new forest (an area about 23% of Lake Winnipeg). We certainly should not be entering into grand schemes of increased cutting of existing forests (Kurz and Apps 1995).

All the world has to do is to divert its spending on armaments and invest in a long-term sustainable vision for itself. The preservation of the taiga — and the survival of the woodland caribou — are within the financial capabilities of the global community. Are they within our ethical capability?

ACKNOWLEDGEMENTS

I am grateful to Dr. R.R. Riewe for his valuable comments on a draft of this paper. I would also like to express my appreciation to the conference Conservation of Northern Forests held in 1995 at the Faculty of Forestry of the University of Toronto, at which the original version of this paper was presented.

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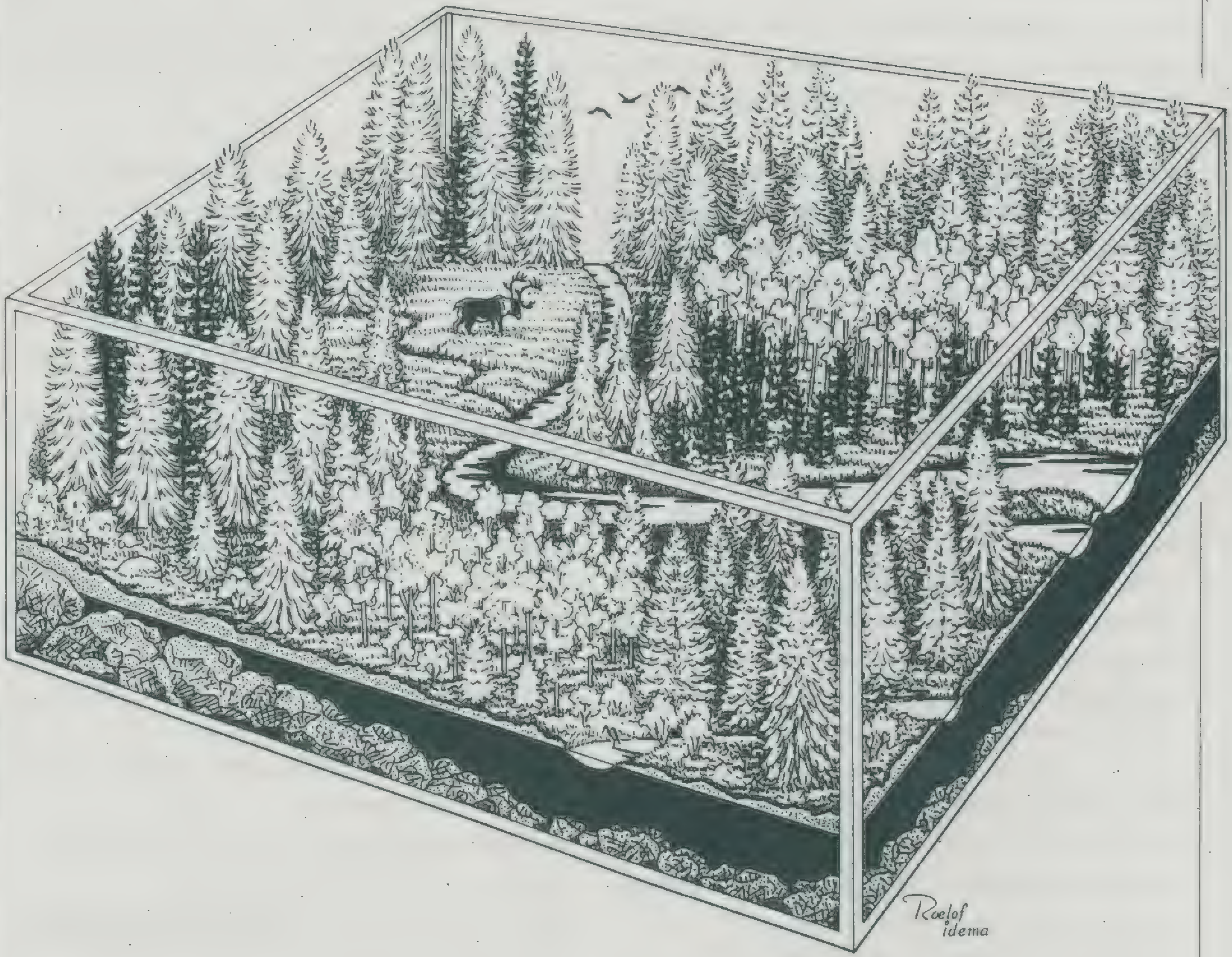
Boreal Forest Cube

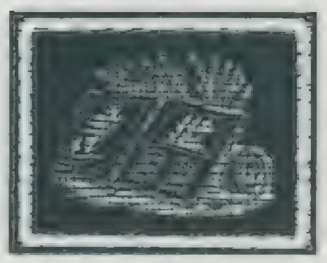
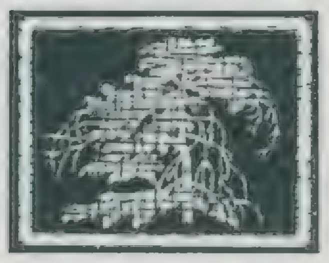
Clear-cutting diminishes the forest's hydrological cycle, sending more of the precipitation directly into rivers and oceans, while ecologically based forestry practices sustain the colossal living tree-cloud-groundwater cycle.

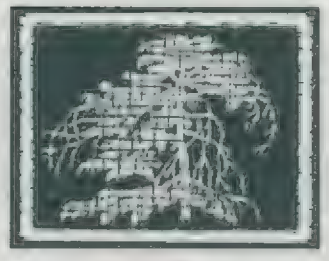
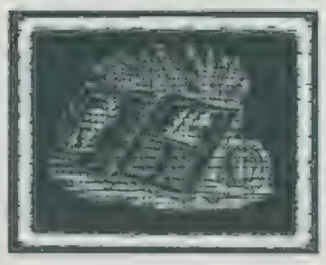


Boreal forests make cover 11% of the Earth's surface worldwide and include white and black spruce, balsam fir, jack or lodgepole pine, tamarack, white birch, and trembling aspen. On the forest floor lichens, mosses, ferns, flowering plants, and shrubs are found. Upright trunks, the canopy overhead, fallen trees, leaf litter, and soils provide habitats for myriads of life forms — from tiny invertebrates and bacteria to larger animals such as white-footed mice, moose, ravens, and plants.

Compared with tropical rainforests, the diversity of species is low. However, boreal forests support distinctive species, and their large areas perform essential ecological services. For example, woody pieces and other organic matter last about 350 years on the boreal forest floor (where clear-cutting and burning is not carried out), compared with 0.7 years in tropical forests. The forests therefore become an important global carbon bank, slowly releasing nutrients into the soil for the next generation of trees.

In addition, boreal forests link unseen underground lakes with clouds in the sky. Rain and snow feed the water table, which emerges at the surface as still or running water. In the soil, hundreds of kilometres of tree roots and fungal filaments collect nutrients and moisture, which flow up to the leaf food factories that are powered by sun's rays. Water is then transpired or "breathed" from small openings in the leaves — as much as 23,000 litres from a hectare of forest — and clouds form from the transpired moisture. Soon rain falls, and the cycle begins again.

Rethinking paper: Non-wood fibres poised for comeback

Heather Rosmarin

INTRODUCTION

On the morning of 6 November 1996, *Los Angeles Times* readers turned a page in paper history. Sixteen pages, to be exact. Although indistinguishable in look or feel from their neighbouring pages, these were dramatically different: they contained 20% agricultural residues — rye, wheat, and rice straw — and these residues replaced half of the virgin wood content of the paper.

Facing a state-wide moratorium on straw burning, a major source of air pollution, California's rice farmers have been seeking new uses and new markets for this raw material. In California and across North America, excess cropping residues — once viewed only as a disposal problem — are now recognized as an enormous and virtually untapped fibre base.

Working with farmers to turn these "ag-residues" into newsprint are Arbokem Canada, a leading producer of totally chlorine-free agricultural pulp, and Smurfit Newsprint Co., a leading manufacturer of newsprint. Additional support for this initiative is coming from many sectors: environmental NGOs, the American Lung Association, the California Waste Management Board, and the US Environmental Protection Agency. This collaborative effort paid off.

The newsprint trial received positive reviews from major west coast newspaper publishers as well as from industry observers. This newsprint run exemplifies recent non-wood fibre successes. In the last three years, non-wood fibres have appeared in paper products ranging from fine writing bond and archival-quality book paper to newsprint, toilet tissue, and reams of ordinary office paper. Results thus far have been impressive. In 1995, HarperCollins printed David Brower's *Let the Mountains Talk, Let the Rivers Run* on 100% kenaf (a fast-growing annual related to hibiscus). Bank of America recently printed an investment portfolio on 50% wheat straw/50% post-consumer paper. Such high-profile demonstrations of non-wood publishing signal change in the wood-based status quo. Non-woods once dominated papermaking in North America (Smith 1997) but have been in virtual exile since the era of pulping forests for paper began in the 1800s. Now, after decades of showing promise in government, industry, and university labs, non-woods are proving practical in diverse "real world" applications. The time is ripe for a non-woods comeback.

Projected scarcity in wood-fibre supply, violent price swings in the North American wood pulp market, and developing markets for excess ag-residues are all creating economic incentives for producing pulp and paper from non-wood fibres. No less significant are the environmental incentives: the tantalizing prospect of a pulp-and-paper industry that is *not* addicted to trees has profound consequences for forest biodiversity.

WHY DE-LINK FIBRE FROM FORESTS?

Since paper cannot be indefinitely recycled (the fibres eventually become too short and weak), the manufacturing process requires a stable and substantial source of virgin fibre. Trees are the North American pulp-and-paper industry's dominant virgin fibre source (see Figure 1). While pulp-and-paper manufacturing in many other countries incorporates high percentages of non-wood fibres (Atchinson 1996), North American manufacturers depend almost exclusively on wood. Even the name of the most prominent US industry group — American Forests and Paper Association — assumes that forests must be "fibrebaskets." There are compelling reasons to discard the assumption that forests and fibre are inextricably linked.

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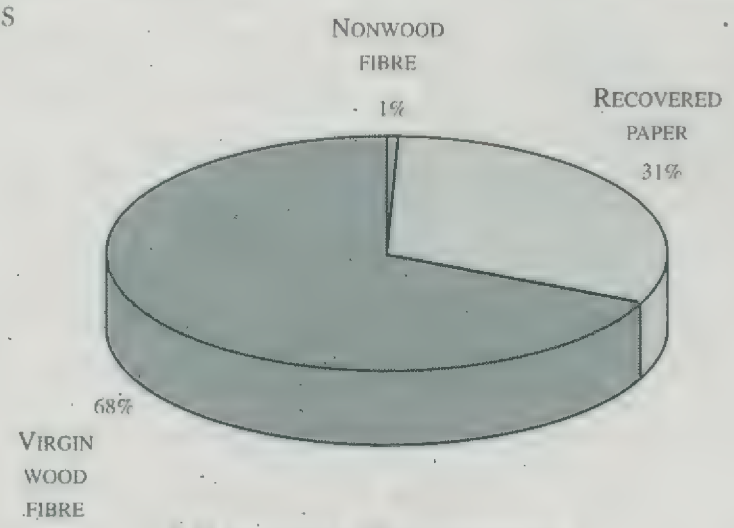
Growing wood consumption threatens forests.

- Nearly half of the world's commercial timber is pulped (Brown 1997). Consumption of pulp and paper has been rising far faster than that of lumber. This consumption, which is projected to double in twenty years, poses an escalating threat to native forest ecosystems in every region of the world.
- This threat is particularly acute in the boreal and temperate forests of the US, Siberia, and Canada. Canada, the world's largest producer of newsprint and market pulp, vividly illustrates the problem. Based on statistics in the Pulp & Paper 1997 North American Factbook, more than 60% of the virgin wood extracted in Canada in 1994 went into pulp and paper. Timber from coastal rainforests feeds the demand for softwood pulp that ends up in magazines and phonebooks. Timber from the boreal forests feeds the demand for hardwood pulp that ends up in newsprint.



US industry fibre sources

Figure 1. Today in North America the bulk of the virgin fibre required in paper manufacturing come from forests. How long can we go on using forests as "fibrebaskets"?

Extant measures are necessary but insufficient.

- Although mounting public concern — reinforced by lawsuits and validated by scientific input — has convinced decision-makers to protect selected forest ecosystems, the rate and extent of such protection cannot offset the pressure created by the escalating demand for wood fibre. In 1995, the US pulp-and-paper industry alone consumed 107 million cords of wood (Pulp & Paper 1996).
- Today less than one third of the fibre used in US papermaking is from recovered sources. In Canada the 1995 figure was approximately 22% (Pulp & Paper 1996). Even if recycling were maximized and the amount of fibre in the material stream thereby increased, infusions of long, strong, virgin fibre will remain a papermaking prerequisite.
- Planting more trees sounds like a solution, but it is not. First, chemically laden, evenly aged tree plantations cannot replicate the biodiverse native forests that they are displacing worldwide. (In the southern hemisphere, farmland is displaced as well (Dudley, 1995)). Second, plantations — oft cited by industry as the environmental fibre alternative to native forests — will not meet the projected worldwide demand for virgin papermaking fibre. The primary reason: they take too long to mature. This anticipated fibre supply shortage, a consistent theme in recent global timber supply studies (Flynn 1995), ensures that native forests will continue to be a target for wood fibre acquisition.

Consumer choice is limited.

- At present, the virgin wood fibre content of a particular product cannot typically be traced to a specific ecosystem. Therefore, consumers cannot easily translate their awareness of the connection between deforestation and paper consumption into action. An independent certification and labelling program would remedy this situation, and although some work on this has begun, the practice is far from being widespread. The obscurity of source is the main reason all virgin wood fibre should be considered suspect, especially if it comes from sites known for clear-cutting in native forest ecosystems.
- A modest supply of Forest Stewardship Council-certified wood chips is likely to develop in the near future. This development will be welcomed. However, the demand for virgin fibre will far outstrip the potential supply from well-managed forests. As forest ecosystems are protected and conserved — or, alternatively, exhausted — wood supply will constrict. Unless demand also constricts and shifts to non-wood fibres, industry will push deeper into dwindling native forest reserves.

For these reasons, analysts increasingly favour a strategy that directly reduces virgin wood consumption by replacing virgin wood with non-wood fibres (Smith 1997). Such a strategy complements existing preservation, conservation, and waste reduction initiatives.

NON-WOOD FIBRES: OPTIONS

The existing agricultural land base is a viable source not only of food, clothing, and fuel, but also of fibre. Imagine meeting fibre needs without destroying forest ecosystems by logging or conversion to plantations.

There are two basic categories of agricultural non-wood plant fibres. "On-purpose" papermaking crops — such as kenaf and industrial hemp — can replace or be rotated into existing crops. Excess cropping "residues" from food and textile crops — wheat, rice, corn, rye, banana, cotton, and flax — which would otherwise be burned or buried, can enter the fibre supply without depriving the soil of nutrients. In the US alone over 200 million tons of such excess residues are suitable for papermaking (Smith 1997).

The intrinsic merits of non-wood fibres (see Figure 2) have long been recognized. Consider the example of kenaf. This hardy annual matures in five months. It is 12–18 feet high and yields 6–10 tons of dry fibre per acre. This yield surpasses that of Southern Pine — an industry yardstick — by 200–500%. The pulp yield is 22–66% higher. It has a lower lignin content than wood and thus requires one-third less energy to pulp. Kenaf's long, strong fibres are ideal as a virgin softwood fibre replacement (Mardon et al 1996).

Kenaf and other non-wood plant fibres are clearly capable of relieving the mounting pressure on forests. But their benefits do not stop there. Pulping wood is energy and water intensive, and the chlorine bleaching of wood pulp releases endocrine-disrupting toxins. Although pollution controls can mitigate these problems, a more elegant solution exists for both source and sink concerns: replace wood with raw materials whose organic composition is more amenable to ecologically sound production processes. Non-wood plants fit the bill.

Of course, as with any resource consumption scenario, danger lurks. The demand burden should not, for example, be shifted from a rainforest to a native bamboo forest. Informed vigilance is critical at this early stage in the industry's development to ensure that the mistakes of the status quo are not repeated.

NON-WOOD FIBRES: OBSTACLES

Resistance to non-wood fibres remains deeply ingrained in North America's pulp-and-paper industry, which has invested billions to control massive tracts of forests and to develop an infrastructure that feeds on trees. This resistance is deepened by government subsidies of logging.

The link between industrial wood consumption and deforestation has long been obscured by timber interests. Under increasing political and consumer pressure, some industry representatives publicly deny that wood consumption for pulp and paper drives deforestation. Others admit that fibre for pulp and paper continues to come from old growth forests.

The following non-wood fibres are currently used in North American papermaking:

- bagasse (residue from sugarcane)
- bamboo (on-purpose perennial)
- cereal straw (residue from wheat, rye, rice)
- cotton linters (residue)
- flax (residue)
- hemp (on-purpose annual)
- kenaf (on-purpose annual)
- pinzote (residue from banana)

Fibres in development include: switchgrass, spartina, red fescue, corn, and elephant grass.

Figure 2. Non-wood fibres used in North American papermaking.

Against this backdrop, it is especially encouraging that a growing number of manufacturers are investing in the research, development, and use of non-wood fibres. Yet many of these same manufacturers continue to see wood as the primary fibre source: their investments are geared to augment rather than to replace wood in an expanding capacity picture.

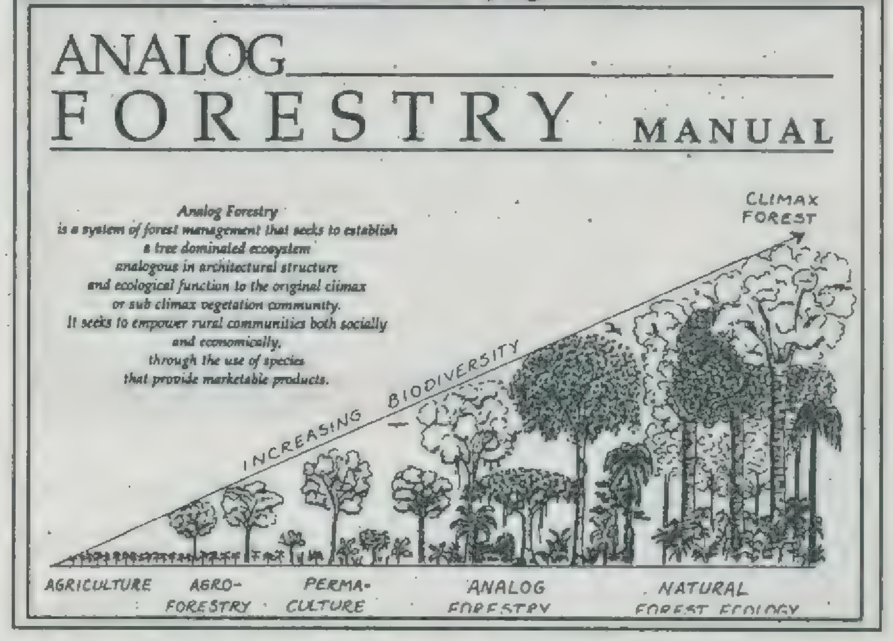
There are, however, a growing number of countervailing constituencies. Farmers, in particular, have much to gain from developing new uses and markets for crops and residues. Accordingly, they are working to overcome key obstacles to non-woods development, including the legalization of industrial hemp. As reported in *Global biodiversity* 6(2): 37, Canadians can now legally grow hemp to produce specialty papers, strengthen recycled paper, manufacture textiles, and produce construction fibreboard.

And, end-consumers — both in North America and Europe — are increasingly demanding ecologically sound paper products. Major corporate consumers are questioning an exclusive reliance on wood fibre after the recent price swings. Printers and graphic designers are incorporating non-wood papers into their design and production processes.

Falls Brook Centre Launches Analog Forestry Manual

The Falls Brook Centre, an ELCI member in Canada, has just produced the first ever guide for farmers and NGOs on analog forestry, a method of silviculture developed by the Neo-Synthesis Research Centre (NSRC) of Sri Lanka. The Manual gives practical guidance on how to design, plant and manage a forest that both increases natural biodiversity and provides extra income for farmers. For more information and copies of the manual ($10.00 each) contact:

Falls Brook Centre, R.R. #1, Hartland,
New Brunswick, E0J 1N0, CANADA.
Fax: 506-375-4221; E-mail: fbcja@web.net


ANALOG
FORESTRY MANUAL
Analog Forestry
is a system of forest management that seeks to establish
a tree dominated ecosystem
analogous in architectural structure
and ecological function to the original climax
or sub climax vegetation community.
It seeks to empower rural communities both socially
and economically,
through the use of species
that provide marketable products.
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INCREASING BIODIVERSITY
AGRICULTURE
AGRO-FORESTRY
PERMA-CULTURE
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ECOFORESTRY INSTITUTE

Each influential constituency is contributing to the momentum of non-woods development. The synergy of demands from these other sectors bodes well for forest biodiversity.

NON-WOOD FIBRES: OPPORTUNITIES

Replacing wood with non-wood fibres will complement and complete other strategies for protecting forest-based biodiversity. The challenge facing concerned parties is twofold: to minimize obstacles to non-wood industry development and to maximize the potential ecological and economic savings. Producers, consumers, and policy-makers have multiple opportunities to meet this challenge.

Producers are encouraged to develop partnerships with their customers, environmental experts, primary non-wood fibre suppliers (farmers), regulators, waste managers, and recyclers.

Consumers are encouraged to reduce overall paper use, choose products created from ecologically sound non-wood and recycled fibres rather than those produced from virgin-wood fibre, and recycle (reusing paper and returning fibre to the material stream).

Policy-makers are encouraged to phase out subsidies for wood extraction, enhance non-woods research and development programs, strengthen air and water protection, legalize industrial hemp, and restructure procurement polices to provide incentives for replacing virgin-wood fibre.

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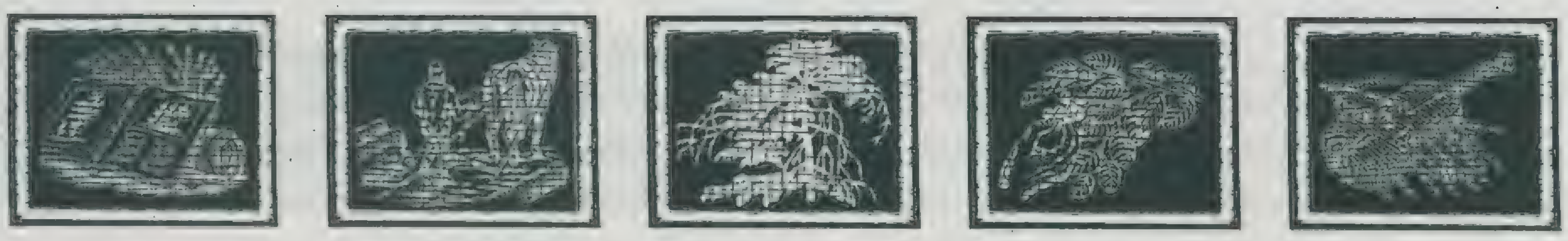

Cloning planet Earth: What can natural selection tell us about the economics of biodiversity?

Viewpoint by Tom Green

INTRODUCTION

In Kurt Vonnegut's *Breakfast of Champions*, a struggling science fiction writer named Kilgour Trout dreams up a short story about the planet Gilgongo, a planet considered unpleasant by its inhabitants because of its excessive diversity of life. The story begins with a big party to honour a man who has managed, after a lifetime of work, to wipe out one species of pandas. On a planet where new species evolve every hour and the best efforts to cause extinctions usually meet with failure, this is a high achievement indeed.

Wouldn't the inhabitants of Gilgongo envy the current rate of extinction on Earth? Surely, they would want to know the secret of our success. They would do well to begin by examining the influence of mainstream economics, which is a large factor in Earth's declining biodiversity.

To convince the Gilgongonians, and perhaps other readers as well, of the usefulness of neoclassical economics in getting rid of countless "troublesome" species, I set out within these pages a thought experiment. This experiment uses the principles of natural selection to explore the viability of different schools of economic thought.

Imagine that scientists go beyond cloning sheep and learn how to clone planet Earth. They clone many copies, each almost completely identical to Earth circa 1997. On each of these planets, there is a global biodiversity crisis and right after the experiment begins, the humans of each planet are induced to follow a different school of economic thought. Let us further assume that the economic theory on each planet is very influential — as is neoclassical economics on Earth at present. The Gilgongonians will see from this experiment that they merely need to adopt the neoclassical model as the basis for their economic policy and then happily watch their planet's biodiversity disappear.

Before undertaking this experiment, however, I will first explain some key concepts of neoclassical economics, environmental economics, and their alternative: ecological economics. Then, following the experiment, and turning to the theme of this issue of *Global biodiversity*, I will show why conventional economic analysis makes ecoforestry look like a poor economic choice in the short term — even though ecoforestry ensures that forests can generate wealth for human and non-human use over the very long term.

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PROBLEMS WITH NEOCLASSICAL ECONOMICS

At present, neoclassical economics rules supreme on Earth. This is unfortunate because this theory and the free-market approach that it engenders does not explicitly deal with biodiversity and indeed contributes to the accelerating rates of extinction. In a nutshell, within this theory, humans are modeled as selfish individuals with insatiable desires, who relentlessly calculate the best means of maximizing their pleasure as they buy and sell in the market. The market then translates this selfish behaviour into socially optimal outcomes; thus the market is the best means to decide how resources are used. Since humans have insatiable wants, the bigger the economic pie, the happier the society. Continued economic growth is of paramount importance.

Mainstream economists, therefore, seek ways to maximize economic growth. According to their theory of free trade, each country should specialize according to its "comparative advantage." In other words, each country

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should make those goods for which its resources, climate, and labour force are best suited. So, for instance, in a world of globalization and open markets, if Canada specializes in growing trees for pulp and Columbia specializes in growing coffee beans, the world output of coffee and pulp should be maximized — over the short term, at least. This may please coffee addicts reading their daily papers, but unfortunately, Canadian and Columbian ecosystems, cultural systems, and economic systems become simplified, and biodiversity is reduced. (Swancy and Olson 1992).

What has mainstream economics forgotten? It has failed to examine the physical requirements of economic growth. By accepting the assumption of limitless wants, it legitimizes high levels of consumption. A consumer society requires the extraction of large volumes of resources; the use of fossil, nuclear, or hydroelectric energy to transform these resources into marketable goods; and the disposal of large quantities of wastes. Each of these steps harms natural habitat, burdens the biosphere, and contributes to the reduction of biodiversity.

Rarely are the linkages between the economy and the ecosystem mentioned, let alone made explicit in trade theory, growth theory, or undergraduate economics textbooks. Of the three "factors of production" used by the early classical economists — land, labour, and capital — neoclassical economists often assume that the land does not need to be considered as part of the analysis. And, when they do keep the land in sight, they rarely see it as more than a building site or a plot of land with indestructible soil that can grow perpetual crops of grain or trees. Unfortunately for the planet, this is likely to be the school of economics that politicians, officials, and business people are most familiar with. Such economic theory — where the "land," not to mention the ecosphere, is conveniently ignored in the analysis — is a significant factor in the decline of biodiversity.

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BUT WHAT ABOUT ENVIRONMENTAL ECONOMICS?

Environmental economics arises out of neoclassical economics, and addresses such issues as resource depletion, pollution, and biodiversity. Donato (1995) explains that, "The over-exploitation of natural resources is largely the result of the current economic systems. Within this context, it is important to evaluate biodiversity since we do not have the financial means to preserve all of the endangered species." Donato then suggests that economists can make an important contribution to the preservation of biodiversity by assigning economic values to species and ecosystems. Donato's assertion is typical of environmental economics.

There are many flaws in assigning dollar values to species and habitats. I shall address just three. First, this approach assumes that biodiversity is an amenity, rather than a necessity. It ignores the fact that continued human economic activity relies on an interconnected, functioning ecosphere in which all "parts" are important. Some economists assume that they can measure the value of biodiversity against the value of reduced economic output, which protection supposedly involves. They do not realize that after a certain point, the loss of additional biodiversity will cause global economic output to drop to zero. In one sense, then, the value of biodiversity is the value of all future economic output.

Second, this approach assumes that it is costly to preserve biodiversity, to avoid global warming, to avoid environmental destruction. However, as Hueting (1996) points out:

> All fundamental solutions for safeguarding the environment are clearly much cheaper than continuing the process that is threatening life on this planet...traveling by bicycle is much cheaper than driving the same distance by car. Heating one room, in combination with a sweater and a blanket, is much cheaper than heating the entire house. A diet combining some meat and beans is cheaper than eating lots of meat....

Third, this approach assumes that if we just knew the dollar value of each species, or habitat, we could make sure that the species we let slip off into oblivion weren't worth the cost of saving them. At the same time, we could protect those that were worth the cost of saving. But biodiversity loss is not due to a shortage of price tags; it is the result of an economic system that fails to respect ecological limits.

Setting aside these objections, how will the value of a species or a habitat be determined? Surveys are frequently the economist's tool of choice. Respondents are asked how much they would contribute to a charitable trust that had been set up to preserve a given species or habitat. From such "willingness-to-pay" surveys, economists estimate the value of biodiversity, all the while noting that "a lack of knowledge about the meaning of biodiversity seems prevalent. This raises concerns over consulting the general public for their valuations of biodiversity" (Splash and Hanley 1995).

Such surveys severely prejudice the rights of indigenous peoples and the rural poor, who don't have the cash income to be part of the willingness-to-pay game. Yet these are the people who are most directly dependent on local biodiversity. How would the value assigned to a given habitat in the traditional territory of a First Nation change if we used a "willingness-to-face-arrest-in-order-to-protect-the-land" criteria instead?

Valuation approaches based on these sorts of surveys and the like need to be abandoned. There is an extensive amount of literature that establishes the impossibility of assigning a correct price to a given environmental "good," such as a species or a service provided by an ecosystem (Gowdy 1994), and that shows that the moral premise for making the attempt is difficult to uphold (Norton 1987). Unfortunately, most economists consistently ignore this literature. Finally, think of the practicalities of assigning values to somewhere around 5 to 30 million species. By the time economists managed to peg a value on even a single species, 30 others would have gone extinct.

Free-market enthusiasts in the environmental economics camp see the problem as poorly defined property rights. The answer, they claim, is to create property rights in species and habitats. Because the owners would benefit from the revenue generated by these privately owned species and habitats, they would act to protect their investments. For example, Anderson and Leal (1991) propose that whales should be privately owned, thus giving these whale entrepreneurs an interest in the continued health of whales.

Still others draw on the pharmaceutical potential of species to suggest that rights in genes should be created (Vogel 1994). However, Simpson et al (1996) calculated that, based on the expected value of new drugs that might be discovered, pharmaceutical companies would be willing to pay a maximum of \$20 to protect a given hectare of rainforest. These figures clearly illustrate the danger of basing biodiversity protection on the private economic benefits that might be derived from species yet to be studied.

If, as Donato states, over-exploitation and the loss of biodiversity are the result of current economic systems, and *if* these systems are supported by current economic theory, is it not time to revisit the roots of that theory and change the economic system? After all, not only is assigning prices to species and habitats unwieldy and complicated, it may well help perpetuate the conditions that are causing the loss of biodiversity. Assigning values to species can be interpreted as demonstrating that it is rational to lose many of our species, to accept the environmental consequences of our global economic order.

Environmental economists recognize that policies based on their analysis are unlikely to lead to sustainability (Pearce and Turner 1990). Yet they are unwilling to suggest fundamental changes to our economic system. This is because their whole analytical framework is built upon determining societal needs by examining the behaviour of individuals in market settings.

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ECOLOGICAL ECONOMICS

For over a century, a small and ostracized minority of economists has been criticizing mainstream economic theory. They have attacked the model of humans as selfish, rational individuals who never have enough. They have pointed to the negative consequences of economic growth (Martinez-Alier 1990). In the 1970s, during the "limits to growth" debate started by the Club of Rome, they pointed to the ecological basis underlying all economic activity — a basis not recognized by mainstream theory. Joined by ecologists and other natural scientists, frustrated by worsening ecological degradation, and convinced that a transdisciplinary approach was essential to understanding economics, they founded an international society of ecological economists (Daly and Cobb 1994; Jacobs 1993; Ekins 1992).

Ecological economics draws on both ecology and economics. However, because it shamelessly seeks to secure the continued viability of Earth for humans and other species, there are marked departures from the neoclassical and environmental economic approaches. First, ecological economists begin with the premise that the economy is a subsystem of the ecosphere and that the maintenance of biodiversity is an essential prerequisite to sustainability. The size of the economy must be limited; a significant proportion of ecosystems should not be exploited or should only experience minimal levels of exploitation. Where ecosystems are exploited, human activity is made to fit within nature's processes. The goals of sufficiency and the "steady-state," where the economy no longer grows but changes qualitatively, replace the goals of unlimited consumption and continuous economic growth.

Gross inequities between people and between regions, such as dire poverty or extreme wealth, are seen as signs of unhealthy economies that result in unacceptable ecological burdens. First, fundamental human needs must be fulfilled. Next human wants can be fulfilled — but only in moderation and not necessarily through consumption. Looking beyond the cash economy, ecological economists recognize unpaid work such as raising children, tending the ill, or volunteering to restore damaged ecosystems. They also seek to strengthen local, informal, and indigenous economies, usually the first to decline following ecological degradation.

Finally, ecological economics recognizes that corporations, including multinationals and transnationals, have excessive power that threatens the ability of citizens, and even governments, in democratic societies to implement the policies necessary for sustainability (Korten 1995). The emerging corporatocracy must be dismantled by dramatically scaling back the rights and power of corporations and by requiring democratic involvement at all levels of society. Economic agreements such as NAFTA, GATT, and MAI, need to be rewritten from the ground up.

THE "CLONED" EARTH EXPERIMENT

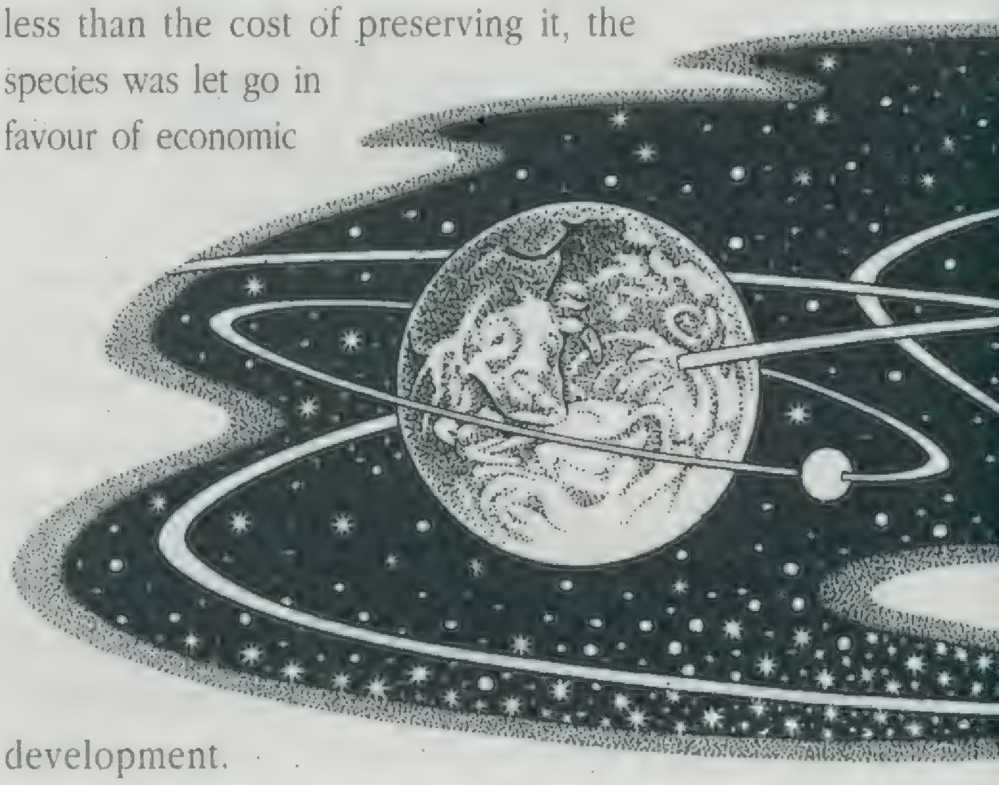
And now...let the grand experiment begin. Having been innoculated with their respective schools of economic thought, the clones of planet Earth are appropriately dispersed through the galaxy. After 1,000 years it is now time to check on their outcomes.

The neoclassical planet

First we visit the neoclassical clone of Earth, where economic theory once supported the single-minded accumulation of wealth, high levels of personal consumption, and the pursuit of endless economic growth. Geologists find that almost all of the planet's surface was disturbed by mining and human settlement, or eroded due to intensive forestry and agricultural practices. Archeologists excavate former enclaves of unimaginable prosperity walled off from vast shanty towns of abject poverty. Most of the enclaves show signs of being burned and looted. Yet apparently the spectacular deluge of extinctions was ignored until it was too late to act. In the resulting aftershocks, biodiversity has declined so much that it is a planet, silent of human laughter and with few signs of higher species (mammals). Obviously neoclassical economic theory was not well adapted for survival: destroying one's host before finding a new one is an evolutionary mistake.

The planet of environmental economics

In the early years of the experiment, the next planet on our tour appeared to give cause for optimism. The writings of environmental economists were being enthusiastically discussed over lattés. Single-industry towns emerged where the sole employment consisted of calculating the value of different species and habitats. When the value of a species was determined to be less than the cost of preserving it, the species was let go in favour of economic development. A complicated scheme of taxes was introduced to influence economic decisions with the aim of protecting those species that were worth preserving.

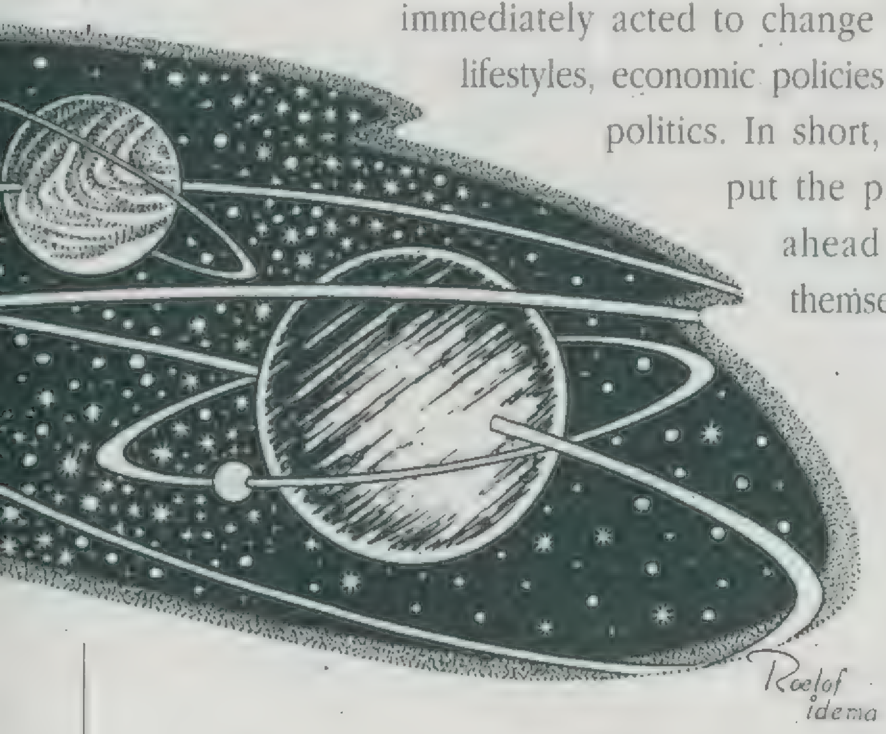


Private property rights were created in various species. Whale owners charged ecotourists for the right to view the whales and take their pictures, but these revenues weren't enough offset the increasing costs of keeping whales in stock as ocean pollution worsened. Historical accounts by interplanetary tourists visiting this planet in the early years tell of auctions unparalleled in the universe, such as the auction of each of the 290,000 species of beetles or a specimen lot of 20,000 lichens! Despite these attempts to optimally protect the environment, public policy remained committed to increased consumption and to economic growth.

However, it soon became apparent that all was not well in the natural world. Bit by bit, species were lost and habitats degraded, followed by a swifter cascade of losses as the web of interconnectedness was seriously fragmented. Yet the inhabitants of this planet were unconcerned at the time, because they believed that the ongoing destruction of biodiversity was taking place in a way that was economically efficient. Slowly, the biosphere collapsed, at a rate only slightly slower than its neoclassical clone. By the time we check in on this planet, it is clear that environmental economics has gone extinct, a victim of its own efficiency.

The ecological economics planet

We next visit the planet where ecological economics quickly became household words. Back in 1998, the inhabitants realized that their planet was in crisis due to the unforgivably high consumption habits of the developed world and the worsening social conditions in the developing world. Fortunately, these inhabitants immediately acted to change their lifestyles, economic policies, and politics. In short, they put the planet ahead of themselves.



Investors, politicians, and consumers demanded that permaculture and ecoforestry replace industrial agricultural and forestry. Industry underwent an efficiency revolution, replacing the linear flows of the industrial age with the closed loops of an industrial ecology approach. Rich countries forgave the debt of the poor nations and helped them fulfill the needs of their inhabitants. Population growth stabilized and then declined thanks to measures oriented to improve the education and societal position of women and children and to widespread recognition of the need to limit and reduce human populations. Throughout the planet, investments were made in ecological restoration.

Selected insights from neoclassical economics have had their place on this planet. For instance, ecological tax reform was implemented without delay, partly based on the neoclassical understanding of how people react to taxes and incentives. Green taxes increased the costs of harmful activities, such as burning fossil fuels, and decreased the cost of hiring labour, solving both pollution and unemployment problems. Yet these "borrowed" insights were used with extreme caution.

The result? At the time of our visit in 2997 some of the inhabitants are leading simpler lives than their ancestors did in 1997. Most now have more food and better shelter. The biosphere is now functioning healthily. Large natural areas support an *increasing* diversity of species. Smaller areas, under community control, have been reserved for meeting the resource needs of the inhabitants in ways that mesh with nature's designs. Stewardship is taken very seriously.

Other planets

I invite readers to extrapolate the viability of other economic theories just as I have done above. For instance, how would a classical Marxist planet fare? (I give *Homo sapiens marxili* little chance of survival.) What other systems of economic thought would be expected to survive? Clearly any theory that does not encourage the inhabitants to respect the ecological limits upon which they depend can only survive as long as the levels of population and technological capacity are very low. This suggests that when we analyze the economy, or a sector of the economy such as forestry, we should do so with a theory that is ecologically viable.

ECONOMICS AND ECOFORESTRY

Now at last, within the parameters of ecological economics, I am ready to examine the special case of the economics of ecoforestry. First, it is clear why so much of conventional forestry-economics needs to be discarded.

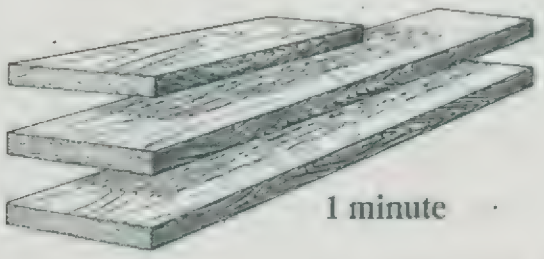
Most economic analyses of timber extraction implicitly assume that the status quo in the forestry industry is ecologically viable: current harvests can continue; tree plantations will grow to order; the soil will keep pushing forth crops of trees on short rotation; there are insignificant ecological losses when we replace a forest ecosystem with a plantation. Current analyses also violate the mainstream economic requirement that revenue derived from consuming an asset not be confused with income (Lutz 1993). In reality, the revenue from the current liquidation of old growth forests should be penalized in economic analysis because we are depleting the natural capital that we should be passing on to future generations.

Ecoforesters admit that an ecosystem-based approach results in timber extraction levels 50% to 80% lower than current industry production levels (Hammond et al 1996). Mainstream economists point out that if timber values are that much lower, government revenue and economic output will be lower, and their final analysis shows that industrial society can't afford ecosystem-based forestry. The result? High volumes will continue to be cut until the assumptions made on paper will trip over reality: forest-dependent communities will discover they are out of wood and living in degraded landscapes.

In contrast, ecological economics supports ecoforestry as an alternative to industrial forestry. Ecoforestry preserves forests — and all the natural capital therein — intact. Ecological economics accepts lower returns today in favour of continued returns in the future.

Specifically, what about the pay of forest workers? Ecoforestry workers are certainly paid less than the forestry workers who work in a highly mechanized industry. Let's not forget, however, that the labour-saving orientation of neoclassical economics has encouraged mechanization, resulting in fewer jobs. Does higher pay for a few make up for lost employment for others in the community? Mainstream economic analysis also assumes that the higher the income, the better. This is not so simple from the perspective of ecological economic analysis. While well-being increases as income rises from bare subsistence, it is also recognized that each additional dollar is of decreasing value. Furthermore, beyond a certain level, higher incomes usually mean ecologically harmful consumption and an increase in social inequity (Wackenagel and Rees 1995). Finally, with ecoforestry, less of the proceeds need to be siphoned off from the community to pay high dividends to distant shareholders. While current industrial forest corporations ship raw logs, lumber, and even wood pulp overseas, local ecoforestry is in an excellent position to generate local secondary forest industries as well as ensuring a *continuing* supply of raw material.

Think about the employment potential of value-added wood products. For example, making 30 board feet employs one person for about one minute. Making a cabinet employs that same person for one to two weeks, and making a violin would employ a person for about two months. (after Hammond 1991)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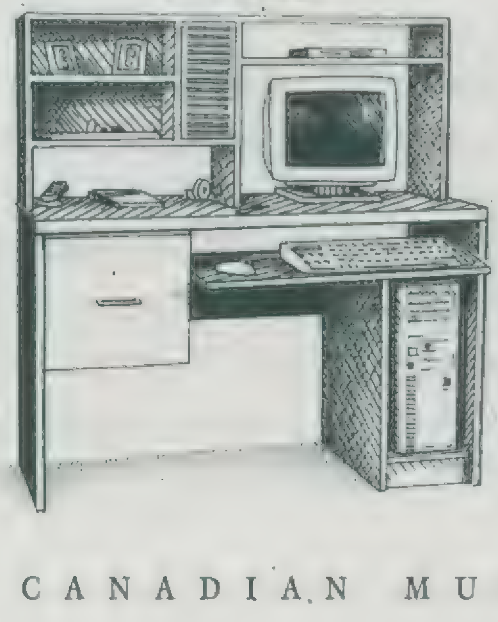
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It is also important to take into account the quality of the worker's experience. Do industrial forest workers feel good about themselves at the end of a day clear-cutting with a powerful feller-buncher? Or would they be satisfied earning a little less, working with more labour intensive technologies that were lighter on the land? Industrial foresters leave behind a disturbed environment; ecoforesters leave behind a fully functioning forest that their children can enjoy — and work in.

Next, let us look at government revenue. At first glance, industrial forestry appears to foot a large portion of the government bill, but this source of revenue needs at least three adjustments. First, industrial forestry eats into the forest capital so it is not true revenue, while ecoforestry aims to live off a portion of the interest. Second, the government in effect subsidizes the forestry companies largely by failing to collect adequate stumpage, by covering costs that should be industry's responsibility and through tax breaks and deferrals. Such subsidies should be subtracted from revenue. Indeed, in most regions of BC, government stumpage revenue does not even cover the cost of Department of Forestry operations. In contrast, by focusing on quality instead of quantity production, and by using open log markets and seeking value-added production, ecoforestry does not depend on government subsidies.

Third, by choosing industrial forestry, government forecloses on other uses of the forest, many of which could generate revenue. For instance, the ecological degradation caused by industrial forestry — witness the extensive landslides in the Clayoquot area in early 1996 — reduces the attractiveness of these areas for ecotourists and decreases the potential for future production of non-timber products. Harvests of anadromous salmon and local trout populations are reduced by irresponsible forestry, diminishing returns for commercial and recreational fisheries. Degradation increases government's financial obligations to cover the cost of restoration, and reduces future government revenue as firms, individuals, and other arms of government cope with a damaged environment. Finally, degradation threatens the timber business itself.

In contrast, ecoforestry does not impose these costs. Ecoforestry generates less revenue from timber, but it does so for the indefinite future, not just the period during which our old-growth inheritance is liquidated and the soil exhausted. Functioning forests also support a number of environmental services, which are essential to economic activity in BC and indeed throughout the world — a benefit impossible to quantify.

Finally, even if over the short-term ecoforestry generates lower levels of government revenue, that is not in itself a reason to stay with the industrial approach. Government revenue should be increasingly derived from taxing ecologically harmful activities, such as putting a carbon tax on fossil fuels. And much present government spending — building super highways, for instance — is ecologically destructive. Government expenditures should be reduced in such areas.

CONCLUSION

To suggest that the current techniques of economic analysis be revised is akin to suggesting a rewrite of the Old Testament. But as seen, the current economic testament leads us to future worlds hostile to humans. In the specific case of forestry economics, the prevalent theories are driving far too many forest-dwelling species to extinction. We need new tools that show industrial forestry as it is — a short-term, expedient, ecologically bankrupt approach that confuses making money with generating wealth. By their very nature, these new tools will also legitimate ecoforestry, by concentrating on livelihoods, on sufficiency, on the long term, and by adopting ecological limits as a constraint.

Unfortunately, these changes will not come from within the economics profession. Outside encouragement is required. Ecologists, biologists, feminists, social reformers, citizen activists, and others need to become familiar with neoclassical economics, the values underlying its assumptions, and the flaws in its models. Economists who do not rework their theories and policy prescriptions to better incorporate a concern for our ecological and social predicaments must be heartily challenged. Public debates on economic matters cannot be left to economists or those who have internalized the neoclassical world view.

Economists and non-economists alike must recognize that mainstream economics has become the indispensable servant of the global free-market economy (Heilbroner 1995). This global economy is destroying the Earth, and the theory that excuses such behaviour needs to be rethought. Until then all those who valiantly work for the preservation of biodiversity or the protection of their traditional territories will find their work undermined by the paralyzing influence of neoclassical economics.

The cloned-Earth experiment allowed us a chance to look at the long-term implications of differing systems of economic thought. Unfortunately, what we are now involved in is not a thought experiment. It is for real. We have only one world, and one experiment.

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Biodiversity, ecodiversity, sociodiversity — Three aspects of diversity

Pierre Dansereau

Professor Pierre Dansereau is Canada's "grand homme de science," and Global biodiversity *is proud to publish his third and concluding piece of "Biodiversity, Ecodiversity, Sociodiversity," dealing with sociodiversity: In considering biodiversity, we should not forget that humankind is part of biological diversity, nor that humans have their own linguistic, cultural, and intrinsic diversity.* Global biodiversity *recognizes Prof. Dansereau's contribution, springing from one of the great roots of Canadian society, that enriches and strengthens our existence and fosters our capacity to respond to global needs. [D.E.M.]*

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SOCIODIVERSITY: SHARING CAPACITY

Phytosociology (Braun-Blanquet 1932) is younger than human sociology. Animal sociology (Allee 1938) is also a tributary of census, of demography, and possibly even more of psychology. I can hardly draw herewith a historical table showing the parallel development and exchanges that have mutually enriched these three disciplines. It is more pertinent to recognize that the emergence of ethology (von Frisch 1974, Lorenz 1981) re-established the continuity from animals to humans. In reference to diversity, I will attempt to reach out to some of these historical developments in the thinking and methodology of biologists, ecologists, and sociologists by taking stock of the categories they have put forth.

I will start by discussing the more complex social interactions, those of humans, and then descend to those of animals and plants. Then I will reverse the pathway by detecting the biological origin of many human forms of behaviour. It can be said that human evolution projects humans to the ultimate reach of biological, ecological, and social differentiations and that in the interaction of human needs (and above all of their satisfactions) reaches its climax and its greatest complexity.

The model of human needs, of the functions of society, and of the welfare of the species that I had proposed (1971a) has been applied on several scales, as shown on Figures 8 and 9. As far as the individual is concerned, such an ordination thus recognizes six orders of needs: a) physiological, b) psychological, c) social, d) economic, e) political, f) ethical (or religious). I will not attempt, in the present context, to justify these choices. In several

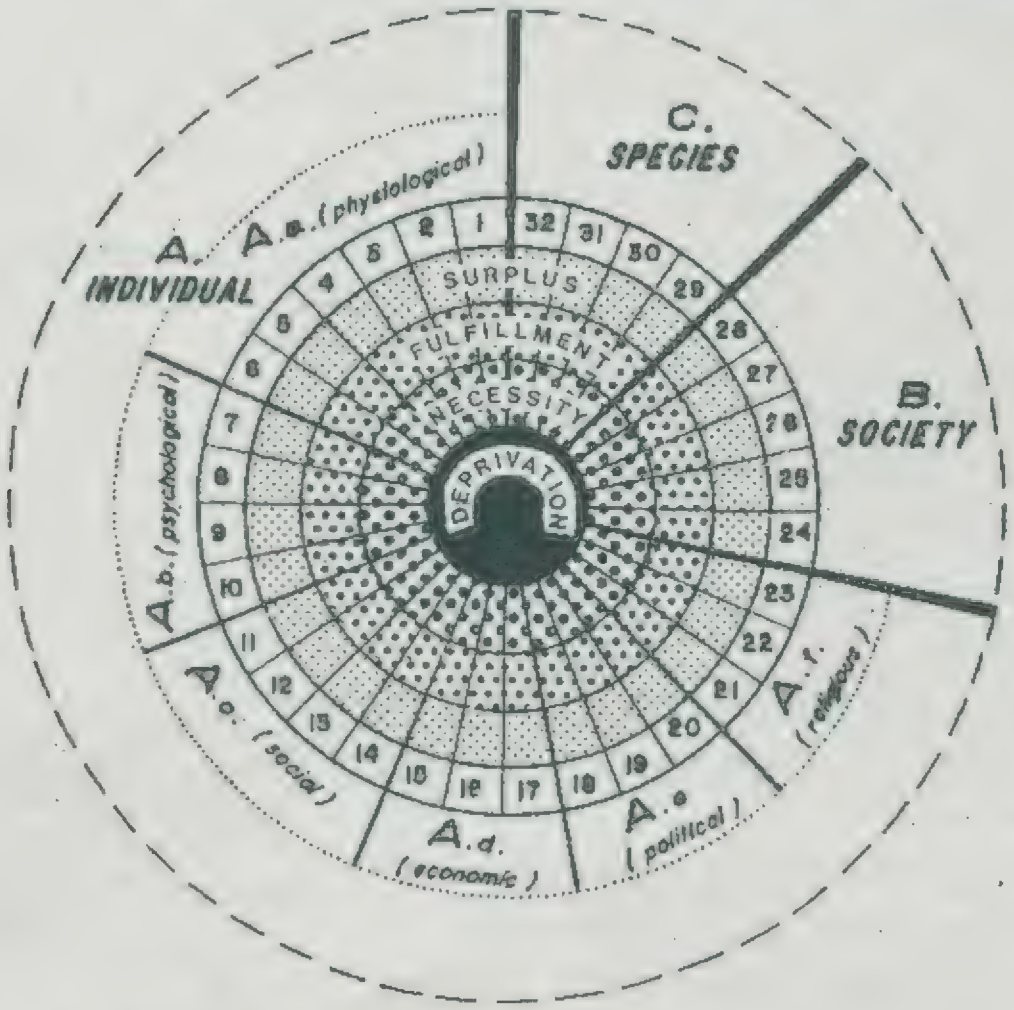
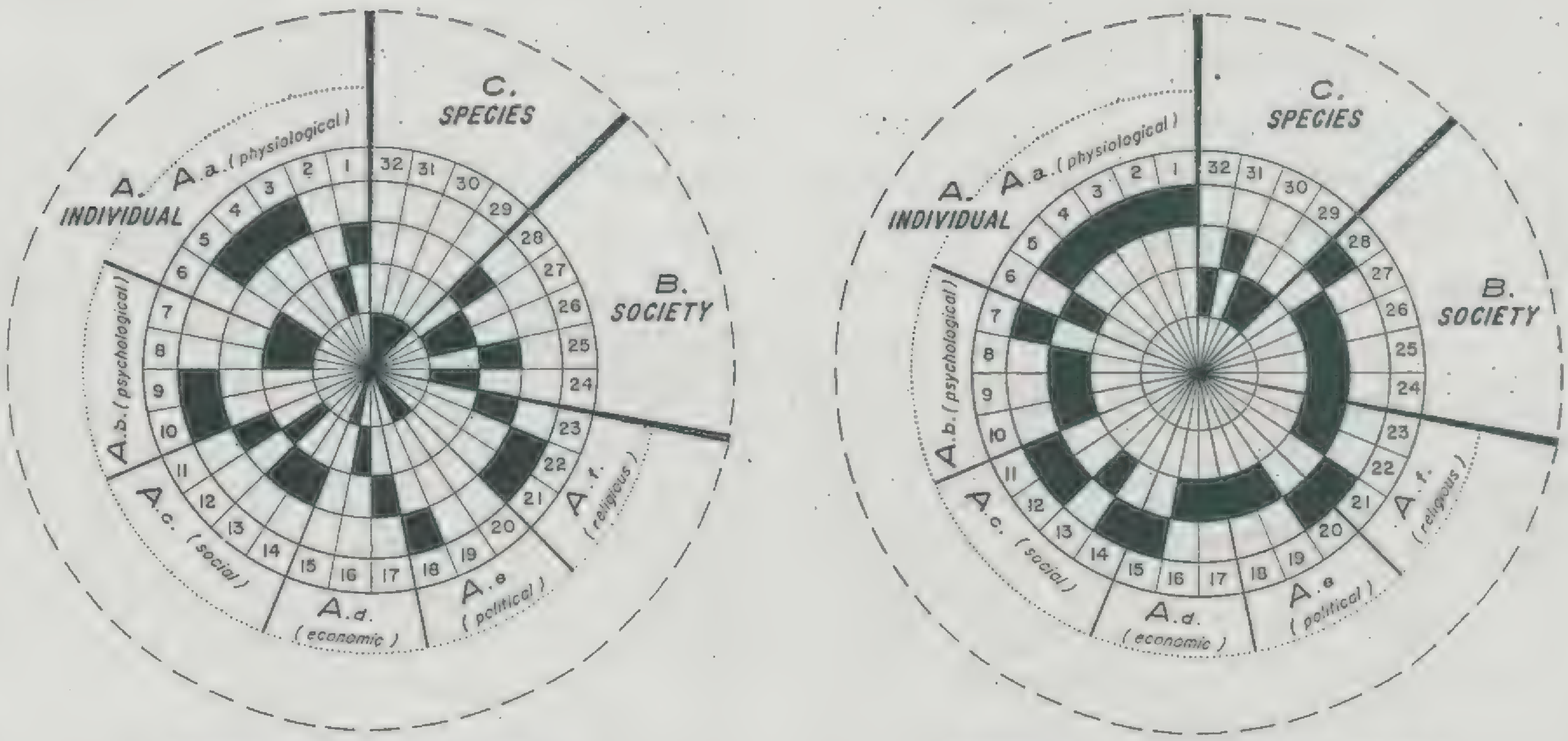


Figure 8. SHARING OF THE "ENVIRONMENTAL PIE."

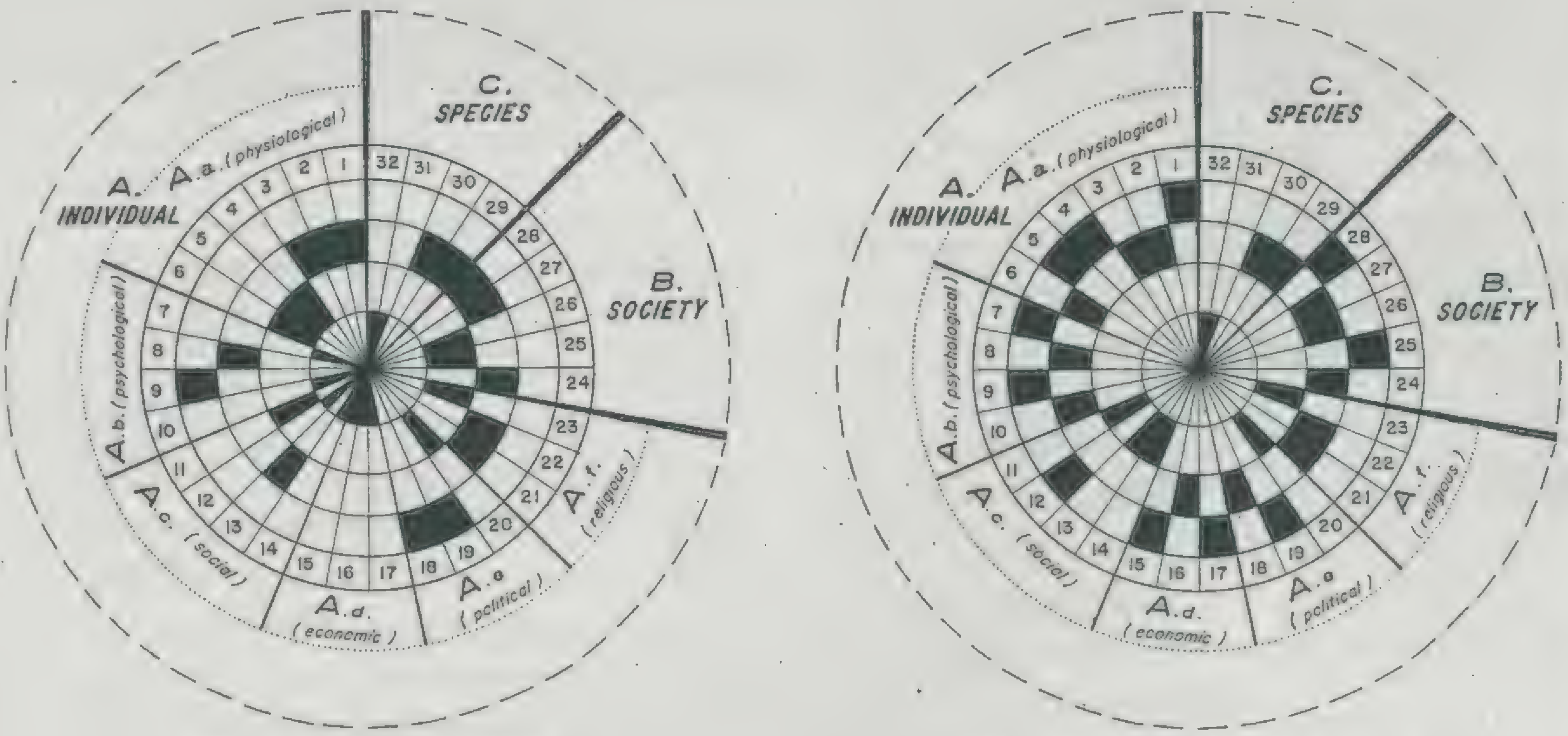
A. The needs of the individual: 1. light; 2. air; 3. water; 4. food; 5. shelter; 6. offspring; 7. space; 8. peace; 9. sex; 10. intercourse; 11. abode; 12. household; 13. work; 14. association; 15. income; 16. decision; 17. property; 18. education; 19. information; 20. participation; 21. faith; 22. worship; 23. ethic. ***B. The functions of the society:*** 24. management; 25. investment; 26. planning; 27. legislation; 28. culture. ***C. The fate of the human species:*** 29. diversity; 30. productivity; 31. aid; 32. health. The four zones of satisfaction of needs: from the centre to the periphery, one can indicate in progressively larger boxes the relative degree of satisfaction.

Figure 9. "ENVIRONMENTAL PIES" SHOWING ECOLOGICAL STRATEGIES ON THREE LEVELS: INDIVIDUAL, PROFESSIONAL, AND COMMUNITY. (Dansereau 1978)



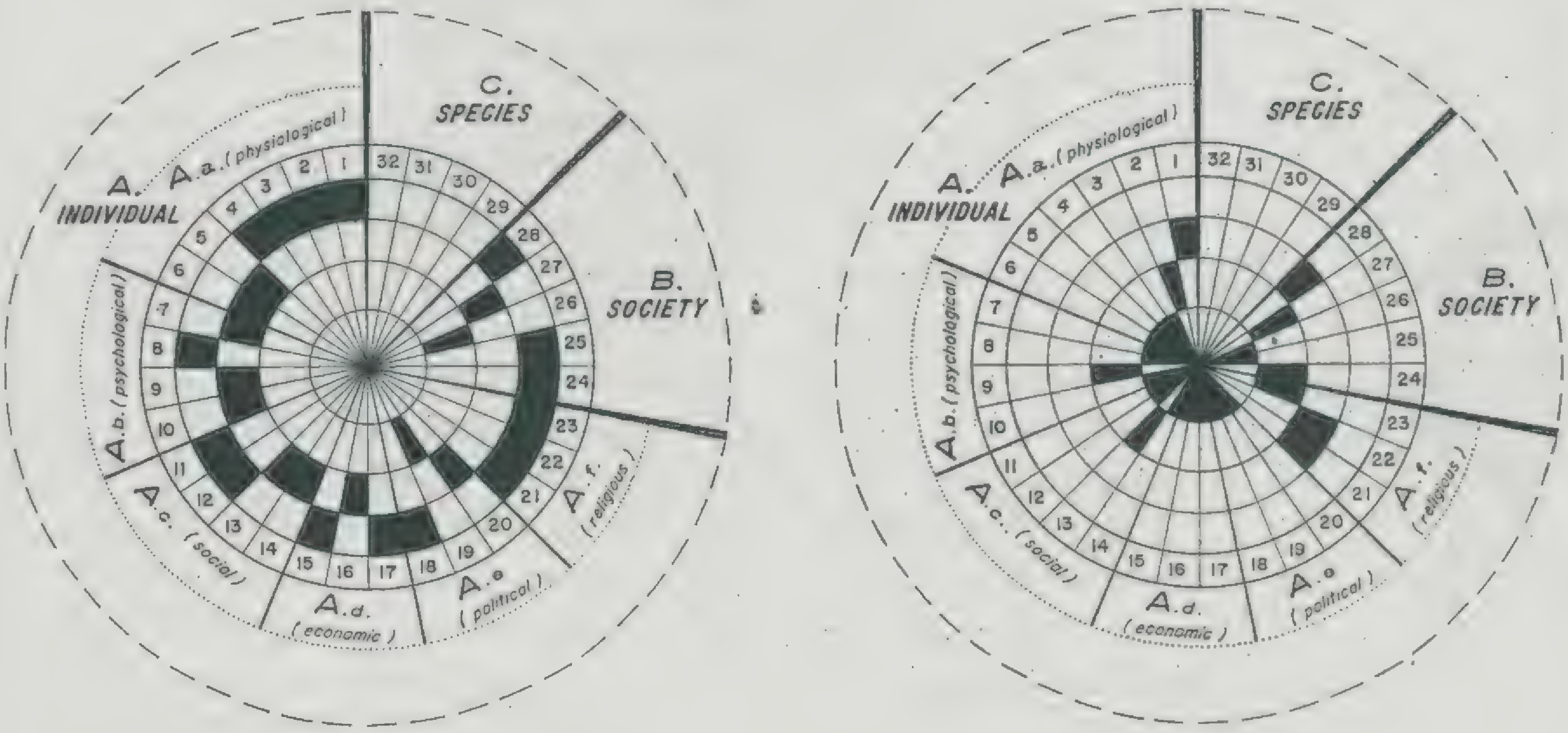
Worker in Montreal, Canada

English teacher in London, England



Student in Montreal, Canada

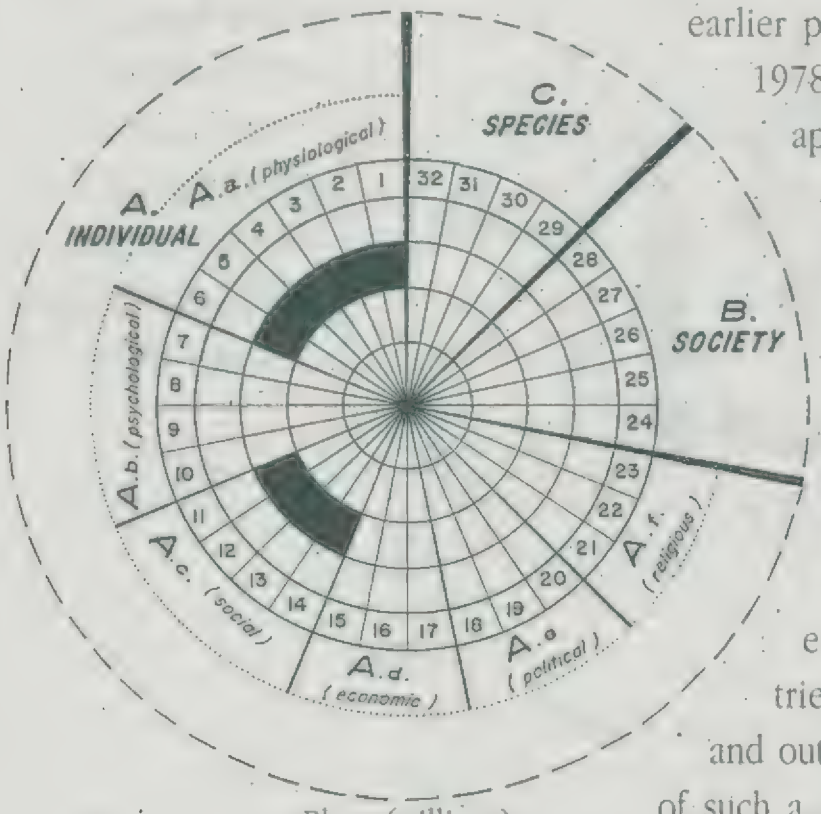
TV performer in Montreal, Canada



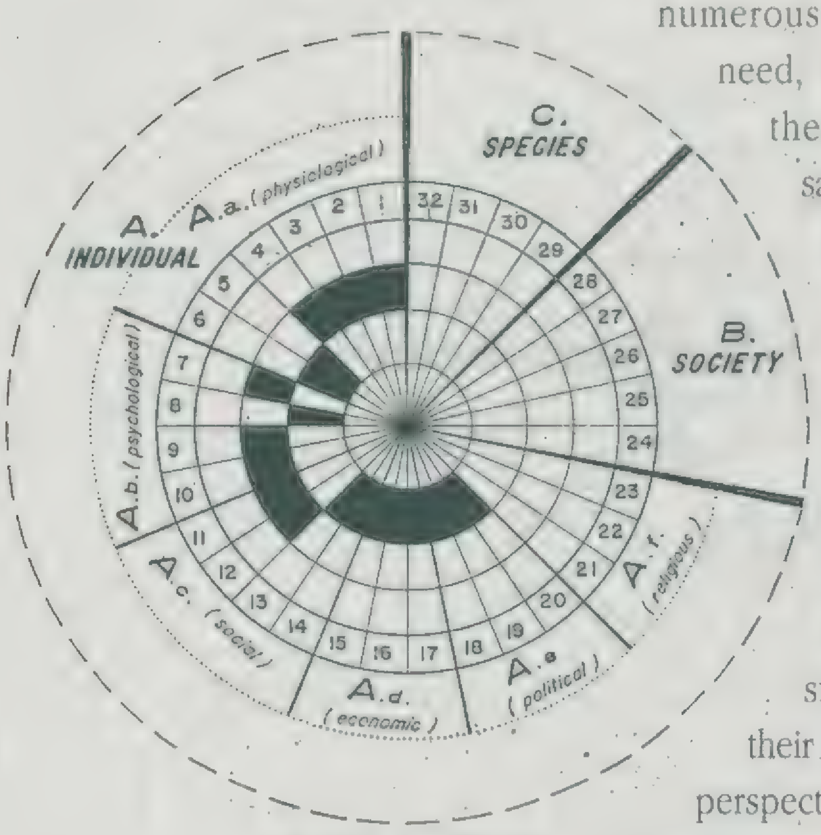
Dunedin, New Zealand

Calcutta, India

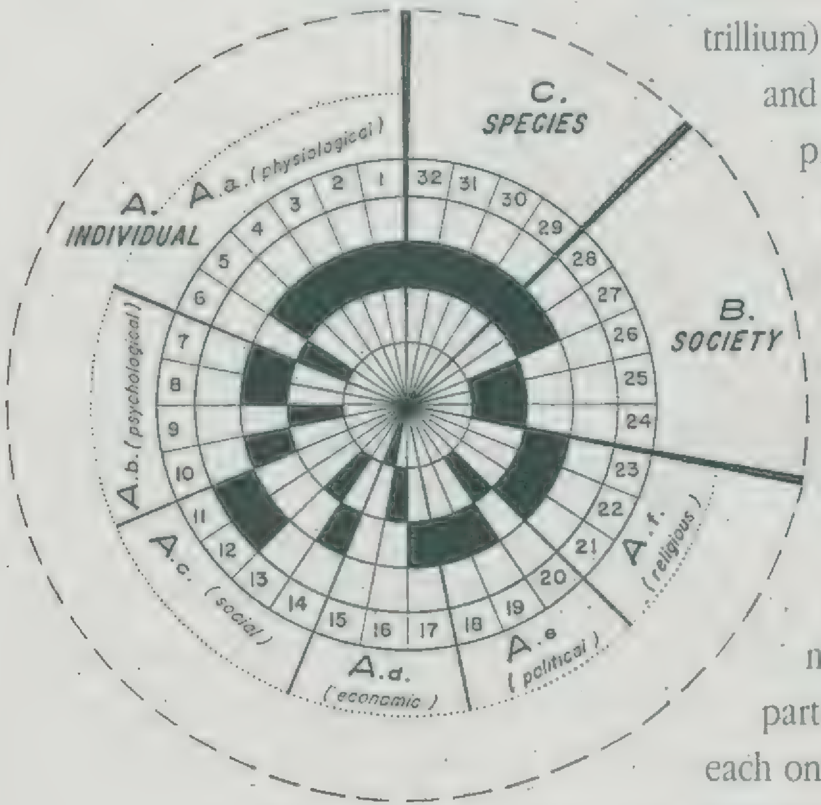
Figure 10.
THE "ENVIRONMENTAL PIE" AS EXEMPLIFIED BY THE THREE AGENTS PICTURED ON FIGURE 3, IN *Global biodiversity* 6(4): 6.



Plant (trillium)



Animal (warbler)



Human (young girl)

earlier publications (1971a, 1977, 1978, 1987), I have made applications (of which a few are reproduced here), also identifying the resources that respond to the need and the trophic level that produces them as well as the environmental forces that constrain them. In a more recent essay (1991, 1994), I have tried to explore the "inside and outside" *(l'envers et l'endroit)* of such a problem, pointing out the numerous discrepancies between need, desire, and capacity and their various degrees of satisfaction.

Still within the framework of the search for diversity, I refer back to Figure 3 (see Part 1, *Global biodiversity* 6(4): 6) wherein a plant, an animal, and a human are encompassed within the successive dimensions of their environment. In the same perspective, Figure 10 shows the satisfaction of needs in a plant (the trillium), an animal (the warbler), and a human, according to the progress that accompanies a differentiation of needs and satisfactions. This method, therefore, situates the living organism in its ecological framework and in its possible responses not only to the non-living environment, but also to its living partners, in its relations with each one of the other species, and with the social matrix as a whole.

Thus are we led beyond the taxonomic enumeration of plant, animal, and human units (indices of the "richness" and therefore the biological diversity within a given space) in order to reassemble them in functional categories. The pathways of evolution have brought about a differentiation that has sometimes resulted in divergence, sometimes in convergence, and either in increasing complexity or simplification. For example, the Compositae, a family that occupies one of the culminating points of plant evolution, has concentrated its flowers in a capitulum, or a close head of many individual flowers, that imitates a single flower. Such a functional form also appears in the Cruciferae *(Iberis)* (candytuft), the Umbelliferae *(Eryngium)* (eryngo), the Euphorbiaceae *(Euphorbia)* (spurge), and the Labiatae *(Monarda)* (horsemint). In their vegetative parts, a great number of species, also without genetic affinities (for instance, the Cactaceae, Euphorbiaceae, Asclepiadaceae, Aizoaceae, Boraginaceae, Compositae, Crassulaceae), have responded to the cumulative pressures of heat and drought by producing candelabra and succulent rosette forms.

Raunkiaer, in 1905, was the first to break with a purely taxonomic characterization. (Or was he following the lead of Theophrastus?) Since so many ferns, gymnosperms, monocots, and dicots had produced similar forms in their evolution, he proposed a classification of *life-forms* based on the position in space of the regenerating organ. First of all, it is notable that annual plants have no such parts, since they lose all of their vegetative tissues and maintain their populations only by seed. The others respond to seasonal pulsations by a more or less effective protection of their buds. Figure 11 shows a detailed breakdown of vegetative life-forms based on this sort of classification.

Many applications of his *life-form* scheme were made by Raunkiaer (1934), producing percentages of each class, which resulted in regional *biological spectra*. Table 3 is a sampling taken from areas all over the globe, with different floras, and yet functioning rather similarly within a similar climate. Possibly the most striking feature is the difference between the dominant life-form in the regional vegetation (trees, or phanerophytes, in the forest; hemicryptophytic herbs in the grassland), and in the flora. Thus, the tropical rainforest has some 60% of phanerophytes, whereas, in the temperate deciduous forest, it is the hemicryptophytes (those plants that die down to soil level during unfavourable seasons) and not the woody plants that reach, by far, the highest percentages, and therefore offer the potentially greatest contribution to biodiversity in this region. Likewise in the deserts, the "ephemerals" (annuals or therophytes) are by far the most numerous, although they contribute very little to the total biomass.

At the more immediate level of the *plant-community,* Table 4 shows four ways of grading the relative importance of life-forms. The contrast between the flora (a) and the other measurements is quite striking. Although the presence of species belonging to a given life-form is important in itself, its contribution to the total biomass is no less significant. Thus in the pitch-pine barren, the 10.5% of hemicryptophytes have a coverage (b) of only 1.9%; the geophytes show an even greater discrepancy, from 5.2% to 0.0001%! In the jack pine barren, on the contrary, the geophytes show 7.9% in the flora with a coverage of 28.7%! In the fescue meadow, the therophytes are 16.1% of the flora but only 7% of the coverage; in the steeplebush brush the ratio is from 9.5% to 3.0%. Constancy (c) and frequency (d) show other dimensions of adaptation.

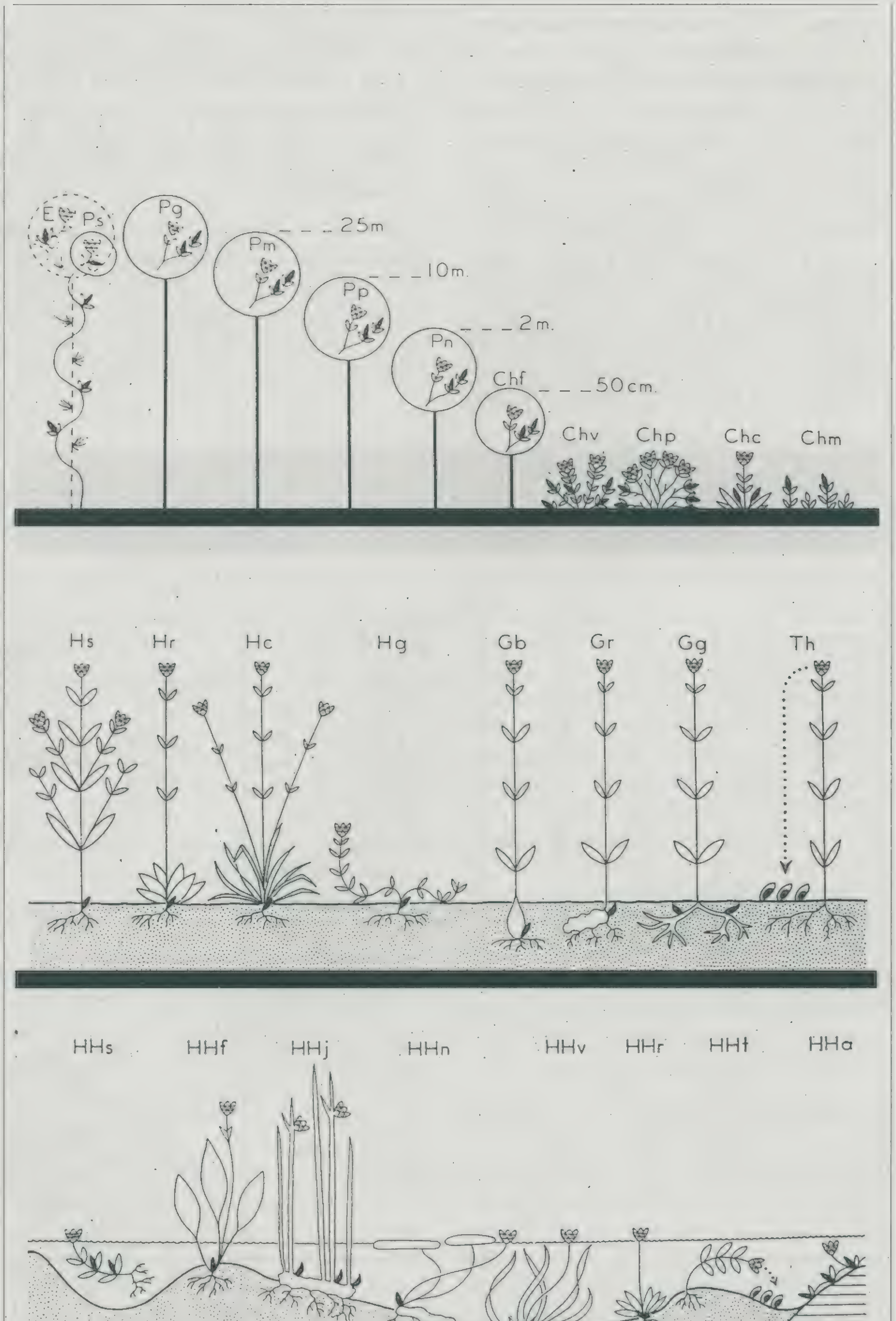
Other methods have been offered, based on more complex structural criteria (Schmid 1955) or on a more detailed sudivision (Du Rietz 1931). I have applied the Raunkiaer system myself, as amended by Braun-Blanquet (1932), to various temperate and tropical environments (Dansereau 1957, Dansereau and Buell 1966).

Table 3.
A SELECTION OF BIOLOGICAL SPECTRA IN DIFFERENT PARTS OF THE WORLD
(based on the distribution of Raunkiaer's life-forms 1934) (see Figure 11).
P = phanerophytes;
Ch = chamephytes;
H = hemicryptophytes;
G = geophytes;
Th = therophytes.
The percentages of distribution are in accord with the bioclimates (Dansereau 1957).

Area	Dominant Life-Form		Climate (Köppen)	Formation Class	Life-Form				
	in the vegetation	in the flora		(Dansereau 1968, 1984)	P	Ch	H	G	Th
World or "normal" (1000 spp.) (Raunkiaer 1934)	var.	P			46	9	26	6	13
Seychelles (Raunkiaer 1934)	P	P	Afi	1	**61**	6	12	5	16
St. Thomas and St. Jan (Virgin Islands) (Raunkiaer 1934)			Afwi	1	**61**	6	12	5	16
Sandy Point, Danish West Indies (Raunkiaer 1934)			Afwi	1	**74**	16	4	1	5
Alps, Switzerland (Braun-Blanquet 1932)	Ch	Ch	E	14	0	**24.5**	68	4	3.5
Spitzberg (Braun-Blanquet 1932)			E	14	0	**26.3**	56.9	14.8	2.0
Eastern Canadian Arctic (Desmarais 1945)			E	14	0	**26.3**	56.9	14.8	2.0
Central Switzerland (Braun-Blanquet 1932)	P	H	Dfc	4	10	5	**50**	15	20
Paris Basin (Allorge 1922)			Cfb	4	15	2	**49**	22	12
Connecticut (Ennis 1928)			Dfb	4	15	2	**49**	22	12
Death Valley (Braun-Blanquet 1932)	P-Th	Th	BSks	18	26	7	18	7	**42**
Cyrenaica (Raunkiaer 1934)			BS	18	9	14	19	8	**50**
Libyan Desert (Raunkiaer 1934)			BS	18	12	21	20	5	**42**

Key to Climate (Köppen)
Afi = wet tropical
Afwi = tropical, seasonal
E = very cold, dry
Dfc = continental, temperate
Cfb = continental, cold
Dfb = continental, very cold
BSks = very dry, warm
BS = warm, dry, seasonal

Figure 11. THE LIFE-FORMS OF RAUNKIAER (1905, 1934). A classification adapted from Braun-Blanquet (1932) and Dansereau (1966). Two examples from eastern North America are given in each case: the first one is a native plant, the second is a cultivated plant; a third plant is a tropical species.



E EPIPHYTES: plants that rest upon the boughs or stems of other plants or even on inorganic substrates
(Usnea longissima, and many other lichens; no higher plants in cold-temperate regions; *Tillandsia usneoides*

P PHANEROPHYTES: Woody plants with regenerating buds at least 50 cm above ground.

Pg **megaphanerophytes:** tall trees, more than 25 m high
(Ulmus americana, Picea abies, Cedrela fissilis)

Pm **mesophanerophytes:** small trees, 10-25 m tall
(Ostrya virginiana, Morus alba, Tibouchina estrellensis)

Pp **microphanerophytes:** tall, woody plants, 2-10 m
(Corylus cornuta, Syringa vulgaris, Musa sapientum)

Pn **nanophanerophytes:** low shrubs, 0.5-2 m
(Spiraea latifolia, Berberis vulgaris, Lantana involucrata)

Ps **climbing phanerophytes:** lianas, climbing or decumbent woody plants *(Celastrus scandens, Wisteria sinensis, Philodendron krebsii)*

Ch CHAMEPHYTES: woody or herbaceous rooted plants, regenerating bud less than 50 cm above the soil.

Ch f **suffrutescent:** diffusely branching and erect
(Vaccinium angustifolium, Rhododendron indicum, Batis maritima)

Ch v **trailing:** decumbent branches not rising much above the soil
(Lycopodium annotinum, Vinca minor, Sesuvium portulacastrum)

Ch c **cespitose:** forming dense tufts or rosettes
(Carex pedunculata, Saintpaulia ionantha, Sansevieria zeylanica)

Ch p **cushion:** forming very dense, compact growth
(Silene acaulis, Androsace villosa, Anabasis aretioides)

Ch m **bryoids:** bryophytes and lichens (and even phanerogams)
(Cladonia rangiferina, Helxine soleinolii, Leucobryum mertianum)

H HEMICRYPTOPHYTES: rooted plants that die down to soil level during the unfavourable (cold or dry) season

Hs **scapose:** with a well-developed stem, branching quite profusely, usually leafy
(Eupatorium rugosum, Campanula media, Ruellia tuberosa)

Hr **rosette:** with a crown of leaves at soil level
(Saxifraga virginiensis, Primula floribunda, Elephantopus mollis)

Hc **cespitose:** with many tufts of short branches arising at ground level
(Danthonia spicata, Zoysia japonica, Chloris inflata)

Hg **decumbent or climbing:** with a weak, plagiotropic stem
(Polygonum cilinode, Ipomoea coerulea, Calonyction aculeatum)

G GEOPHYTES: plants with regenerating buds well under soil level

Gb **bulb:**
(Allium tricoccum, Tulipa gesneriana, Hymenocallis declinata)

Gr **rhizome:**
(Smilacina racemosa, Iris germanica, Alpinia speciosa)

Gg **root:**
(Asclepias syriaca, Dahlia variabilis, Spiranthes tortula)

Th THEROPHYTES: plants which survive only by their seeds

Th 1 **annuals:**
(Impatiens capensis, Alyssum saxatile, Malvastrum coromandelianum)

Th 2 **biennials:**
(Oenothera biennis, Althaea rosea, Leonurus sibiricus)

HH HYDROPHYTES: true aquatics (subdivisions herein according to Dansereau 1945)

HH s **free-living, submerged, or emerged, floating plants:**
(Ceratophyllum demersum, Salvinia natans, Pistia stratiotes)

HH f **emerged aquatics with broad leaves:**
(Pontederia cordata, Nelumbo lutea, Sagittaria lancifolia)

HH j **emerged aquatics with thin (reed-like) stems and/or leaves:**
(Scirpus acutus, Cyperus papyrus, Eleocharis interstincta)

HH n **floating-leaved rooted aquatics:**
(Nymphoides lacunosum, Nymphaea zanzibarica, Limnanthemum humboldtianum)

HH v **submerged aquatics with ribbon-like leaves and/or stems:**
(Vallisneria americana, Potamogeton crispus, Thalassia testudinum)

HH r **submerged rosette plants:**
(Lobelia dortmanna, Isoetes palustris, Alisma tenellum)

HH t **submersed annuals (hydrotherophytes):**
(Limosella aquatica, Naias guadalupensis, Naias marina)

HH a **epiphytic or epilithic aquatics:**
(Fontinalis spp., *Podostemon* spp., *Helianthium tenellum)*

Table 4.
A COMPARISON OF LIFE-FORM SPECTRA
(see Figure 11)
as established from:
(a) list of species;
(b) cover data;
(c) constancy points;
(d) frequency points
(Dansereau 1957).

Area	Plant Community	Author	Number of Species	Basis of %	Life-Form				
					P	Ch	H	G	Th
Lebanon Forest, New Jersey	Pitch-pine barren	Stern and Buell 1951	19	a	84.2	0.0	10.5	5.2	0.0
				b	98.1	0.0	1.9	0.0001	0.0
Lake Itasca, Minnesota	Jack-pine barren	Stern and Buell 1951	63	a	23.8	4.7	60.3	7.9	3.1
				b	11.8	2.5	55.6	28.7	1.4
Granby, Quebec	Fescue meadow	Dansereau and Gille 1949	57	a	1.7	1.7	74.2	6.3	16.1
				b	2.0	4.6	81.1	4.3	8.0
Granby, Quebec	Steeplebush brush	Dansereau and Gille 1949	84	a	7.2	5.9	65.5	11.9	9.5
				b	10.0	7.0	71.0	9.0	3.0
Great Smokies, Tennessee	Cove hard-woods, whole flora	Cain 1945	113	a	36.3	4.4	30.1	25.8	3.4
				c	31.1	5.9	33.1	26.9	3.0
	Herb layer only, vernal aspect	Cain 1945	72	a		7.0	47.2	40.3	5.5
				c		9.0	48.0	39.0	4.0
				d		11.0	43.3	41.9	3.8
	Herb layer only, aestival aspect	Cain 1945	75	a		6.6	61.3	29.3	2.6
				c		8.1	58.1	31.1	2.7
				d		14.2	58.6	23.9	3.5
Piedmont, North Carolina	Oak climax, autumnal aspect	Buell and Wilbur 1948	89	a		0.0	92.3	7.7	0.0
				d		0.0	92.3	7.7	0.0
Itasca, Minnesota	Hardwoods	Buell and Wilbur 1948	145	a		4.3	68.8	26.9	0.0
				d		3.6	60.4	36.0	0.0

Life-forms may be excellent indicators of sociodiversity, but other adaptations of plants are surely just as epharmonic. In 1961, 1966, and 1971b, I tried to classify plants in terms of their *coenotypes* or their function within communities or ecosystems according to the eight criteria found in Table 5.

It is by examining *all* of these traits one by one that a scale can be devised that will reveal the more significant differences, and therefore the range of diversity and the relative dominance of certain adaptations at various orders of environmental magnitude (i.e. at the regional level or at the ecosystem level, or on the more immediate scale of community). The coenotypic pattern will reveal a certain sociological strategy within which each unit is bound to operate. Each of these eight criteria lends itself to a classification of plants according to distinct aptitudes and responses. As far as the autecology, or specific responses of individuals, and the synecology, or social responses, of animals and humans are concerned, no such clearly stereotyped classifications are available, and the studies that have been made according to different objectives and methods have yet to be translated into an ecological vocabulary. Table 5 is an attempt to do just that.

The eight criteria, displaying parallel results for plants and animals, including humans, have been useful in characterizing each taxon (trillium, warbler, young girl of Figure 3) on the autecological plane. At the synecological level, a forest, a bog, and a house all harbour communities that fit into ecosystems. It is mainly at these two levels that biodiversity is seen to adjust to ecodiversity in terms of ecotopes, niches, and cycling regimes.

It remains to explore the *dynecological* level, or the potential for change within the communities within the ecosystems wherein sociodiversity rests, and that of the ecosystems within their respective landscapes, beyond which lies the adjustment of the latter to their mutual bioclimate. Thus the *stability* of the plant- or the animal-communities is greatest in the central part of their evolution in time. This stability is conditioned both by *autogenic* (self-induced) forces, and by *allogenic* (incoming) external forces. Change, in both space and time, is necessary but it is checked or slowed down in the centre of the evolutionary time line.

The mosaic of landscape in its regional frame will depend, in the ascending order of ecosystematic forces upon:

I. climate, relief, and soil;
II. vegetation;
III–IV. animal life;
V. investment (storage; damming etc.) and;
VI. controlling forces (management, planning, etc.)

(See Figures 1 and 2 in Part 1, *Global biodiversity* 6(4), pages 4 and 5 for a fuller understanding of these trophic levels.) The play of input — output of nature before humanity will or will not be modified by human occupancy (of an ever-escalating strength on the landscape), so that conflict resolutions in an at least partially managed territory will have cast their stamp on the landscape.

In conclusion, sociodiversity results from the multiplicity of roles assumed by the biological agents in a community or an ecosystem. The range of exploitation opportunities calls for the responses of plants, animals, and humans amenable to a complementary and coordinated cycling. It is, therefore, a pattern of resource sharing that emerges. Greater or lesser *biodiversity* at the genetic starting point encounters equal or inferior opportunities in *ecodiversity*, and the more or less harmonious conjunction of these potentials is assisted by a variably efficient *sociodiversity*.

CONCLUSION

The strategy that promotes or imperils biodiversity can best be understood by tracing the behaviour of species (taxons) in their ecological integration (ecodiversity) and in their sociological adjustment (sociodiversity). It has long been agreed among conservationists that no species (taxon) can be effectively *favoured* other than by the

Table 5. CRITERIA APPLICABLE TO THE GRADING OF COENOTYPES.

Criteria	Plants	Animals	Humans
1. Habit and size, form and dimension	tree, shrub, herb, liana	weight, volume, size	build, musculature, hormonal type
2. Vegetative aspects: vital exchanges with the habitat	size, form, texture of stems, leaves, roots	structure and texture, pigmentation, pubescence	hormonal regime, pigmentation, pubescence
3. Phenology: response to circadian and seasonal rhythms	responses of each phase of the cycle to light, to water, to heat	responses of each phase of the cycle to light, to water, to heat	responses of each phase of the cycle to light, to water, to heat
4. Biocoenotic type: morpho-physiologic and epharmonic disposition	rooted, epiphytic, parasitic, symbiotic, saprophytic, free-living	morphology and physiology	morphology and physiology
5. Metabolic regime: methods of intake and assimilation of resources; longevity	annuals, perennials; herbacous, woody	systems of assimilation, of functioning, and of change	food regime, hygiene, life-style habits
6. Ecological valence: amplitude of responses to environmental factors	eury-, amphi-, steno-	eury-, amphi-, steno-	eury-, amphi-, steno-
7. Capacity for reinvestment: quality, quantity, and periodicity of products and wastes	frequency, abundance, assimilability of products and wastes	frequency, abundance, assimilability of products and wastes	domestic and public economy
8. Vagility: extent, frequency, means, and amplitude of movements	means and efficiency of dispersion and migration	means and efficiency of movement, dispersal and migration	geographic, social, and economic mobility

protection of its harbouring habitat, in the ecosystem(s) in which it is found.

The knowlege that is required, therefore, emerges at three successive levels.

Biodiversity *in any area (small or large) rests in the uniqueness of its existing plant, animal, and human composition.* Each unit (taxon) has built up a genetic potential that may have been increased during optimal periods and decreased in pessimal periods, this side of extinction. The total extent of such a potential is readily seen at the generic level: species of *Artemisia, Calamagrostis, Crocus, Danthonia, Typha,* and *Pteridium* are to be found in a wide range of latitudinal and altitudinal zones and in a broad spectrum of topographic and ecological habitats. The case of the genera *Pinus* and *Quercus* is so dramatic as to evoke a sort of "batrachomyomachia" (a legendary battle between the frogs and mice!) for the dominance of the contemporary cold-temperate Northern Hemisphere. On the other hand, in New Zealand, the hidden potential of *Pinus radiata* (Monterey pine) and *Pinus ponderosa* (Yellow pine) has revealed both the limitations of hereditary fixations and the emergence of latent capacities. Both of these species were once widespread under the equable Miocene climate (Mason 1932, Cain 1944), whereas under present conditions *P. radiata* is confined to the Monterey Peninsula in California, and *P. ponderosa* ranges through so many degrees of latitude (Stage 1952 in Dansereau 1957, Strahler 1970) that it has developed photoperiodic races. In New Zealand and in parts of Australia, Monterey pine shows an amazing rate of growth and a perfect adaptation, as though it were back in its old Miocene home. Conversely, the yellow pines have a longer or shorter growth period according to the similarity of latitude of the introduced seed.

Ecodiversity *is measured in terms of the opportunities offered to available taxons by the spectrum of its resources.* Within the constraining forces of a regional bioclimate, the resources of relief, soil, air, water, and biota are continuously (although unevenly) reassembled, thereby often challenging existing fitness and efficiency of living beings in each spatial unit. The charting of environmental gradients is the necessary background to determine the harbouring capacity of each landscape. How well each taxon is established in the landscape is a function of its inherent requirement in conjunction with its potential for tolerance possibilities. Thus, stenotopic species (those species whose opportunities for response are narrowly defined) such as the sugar maple *(Acer saccharum)*, the Brazilnut tree *(Bertholletia excelsa)*, the pitcher plant *(Sarracenia purpurea)*, and the Pyrenean ramonda *(Ramonda myconi)* are excluded from many whole regions. On the contrary, eurytopic species, like the bracken fern *(Pteridium aquilinum)*, the reed *(Phragmites communis)*, the scotch pine *(Pinus sylvestris)*, gorse *(Ulex europaeus)*, manuka *(Leptospermum scoparium)*, and the trumpet tree *(Cecropia peltata)* encounter frequent opportunities notwithstanding even climatic change, since they can cross a number of edaphic boundaries. Yet others, that are stenotopic, are capable of crossing climatic barriers: the coconut *(Cocos nucifera)*, lyme grass *(Elymus arenarius)*, the Australian pine *(Casuarina equisetifolia)*, the mangrove *(Rhizophora mangle)*, the beach morning glory *(Ipomoea pes-caprae)*, and the silver maple *(Acer saccharinum)*. The phenomenon of preadaptation is here very much in evidence.

Sociodiversity *refers to role-playing, whereby a taxon that has encountered a suitable niche within a community is able to achieve permanence therein.* Ecological success runs a spectrum that ranges from mere presence to dominance. In a Laurentian maple forest, such species as the putty root orchid *(Aplectrum hyemale)* and the showy orchid *(Orchis spectabilis)* while present are neither constant, frequent, or abundant; the Canadian violet *(Viola canadensis)* is not constant, but it is frequent and abundant on limestone soils; the green osier *(Cornus alternifolia)* is constant and frequent but never abundant; the dogtooth violet *(Erythronium americanum)* is constant, frequent, and very abundant; the black cherry *(Prunus serotina)* is not constant, sometimes frequent, never abundant; the sugar maple *(Acer saccharum)* is constant, frequent, abundant, and dominant.

It remains to apply this three-level compass to a number of ecosystems and landscapes. Too little attention has been paid to the receptivity of ecodiversity and almost none to sociodiversity (as here defined). By far the greatest number of publications and symposia has reflected *the political means of saving diversity,* with too little reference to the *nature of diversity.* The above proposals are a bare outline of three sets of criteria and of their correlation in the comprehensive analysis that should precede an enlightened *ecodecision.* The latter has been admirably defined by di Castri (1997) in a perspective of retroaction of sociodiversity upon eco- and biodiversity. The politico-economic forces are thus considered in the light of all-embracing ecological dynamics.

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ERRATUM

In Part 2, the following sentence should have read as follows:

Likewise, the spikerush *(Heleocharis acicularis)* can produce its abundant rosettes of leaves only under complete immersion, whereas it cannot flower unless it is emersed (i.e. not "immersed").

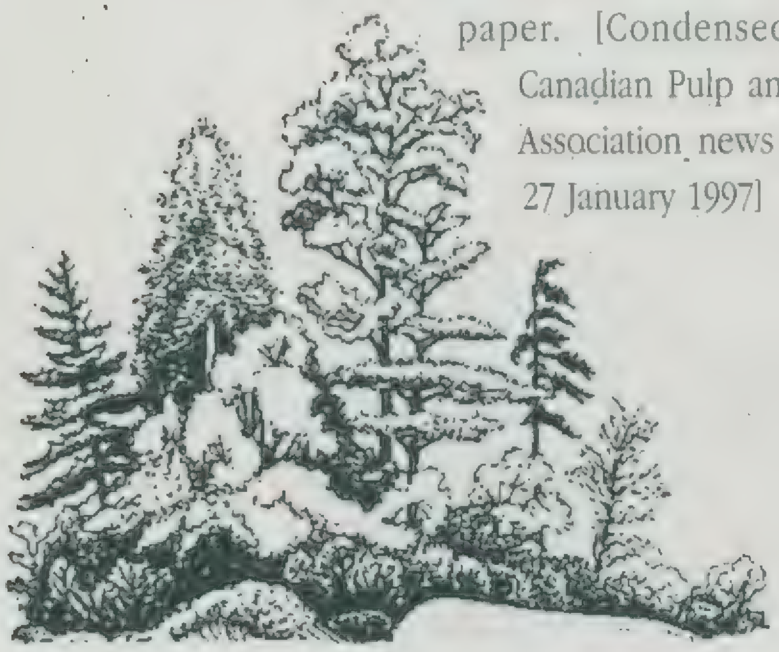
Global biodiversity 7 (1), (page 8, para 1, lines 7 and 8)

Biodiversity news

Canadian Pulp and Paper Association announces 1996 environmental highlights

Here are some of the highlights:

- A new $88-million five-year research program was launched to develop closed-cycle technologies for Canadian mills, shifting the emphasis from end-of-pipe treatment to pollution prevention.
- New national standards for sustainable forest management were welcomed.
- Since 1990 Canadian mills have reduced CO_2 emissions from fossil fuels by 20% due to a shift away from using non-renewable fuels; energy efficiency has improved by 7% on a per-tonne of production basis since 1990.
- Since 1990 Canadian mills are recycling 150% more, and in 1996, used 4.5 million tonnes of used paper. [Condensed from Canadian Pulp and Paper Association news release, 27 January 1997]



Over 80 organizations oppose Global Forest Convention

On the eve of the fourth and final session of the U.N. Intergovernmental Panel on Forests, more than 80 organizations from around the world called on world leaders to reject a convention, and instead to pursue an alternative strategy to safeguard the world's forests from further decline. The organizations, representing millions of people worldwide, believe that a forest convention negotiated at this time will not only fail to effectively safeguard the world's forests, but could actually threaten them. They are worried that a premature convention could:

- **Enshrine weak standards** in forest management and thus cripple several existing, and stronger, forest initiatives;
- **Favour commercial trade interests**, dominated and driven by powerful timber and commercial trade interests;
- **Undermine the biodiversity convention;**
- **Avoid the real issues**, many of which lie outside the traditional "forest" sector, and thus fail to effectively address the chronic underlying causes of forest loss and degradation;
- **Threaten citizen initiatives** (e.g., the independent certification of forest management and forest products) and undermine the ability of indigenous peoples and traditional rural communities to help decide the fate of their own forests; and
- **Delay decisive action** through years of lengthy debate, negotiation, and ratification over the proposed convention.

According to the group, whose overriding interest is in solutions and results, there is no clear evidence that a global forest convention is either necessary or desirable. The group lacks confidence in a new convention when it already appears difficult for many governments to implement their existing commitments to protect forests and use them sustainably. They propose an alternate strategy, which would make full use of existing international agreements and mechanisms to take timely action; take a strategic, problem-solving approach to eliminating the underlying causes of global forest decline; and build broader international consensus through a variety of regional, bilateral and focused multilateral agreements. [Condensed from a declaration posted on EcoNet, 10 February 1997. Contact: Bill Mankin, Global Forest Policy Project, Tel: (202) 797-6560, Fax: (202) 797-6560, E-mail: <bmankin@igc.apc.org>]

Global ecological functions of biodiversity worth US $33 trillion

The publication of "The value of the world's ecosystem services and natural capital" by Robert Costanza et al in the 15 May 1997 issue of *Nature* has raised a storm of discussion. In part, the discussion focuses on the size of the value itself — some US $33 trillion — and in part, the discussion focuses on the attempt to bring the free ecological functions and services that support the ecosphere, including humanity, into the world's economic system. It is a bold effort and contains some deep and challenging thinking. The paper is being discussed on the ISEE-Forum, Committee for a Sustainable Future at <listproc@csf.colorado.edu>. You can join by sending the word "subscribe" in the body of the e-mail. Tom Green also discusses whether or not we can put a value on biodiversity in his paper "Cloning Planet Earth" on page 37 of this issue. [D.E.M.]

Two oil companies shift towards solar energy, recognizing climate change

Among nations and within nations, transnational and lesser corporations have used their powerful influence to set up roadblocks to serious government moves to reduce emissions of greenhouse gases. Now two petroleum giants, British Petroleum (BP) and Shell, have split from the rest of the oil industry. They agree with environmentalists and scientists that oil companies should recognize the threat of human-made climate change by moving to alternate energy sources, such as solar power. John Browne, chief executive of BP said that, "There is now an effective consensus among the world's leading scientists and serious well-informed people outside the scientific community that there is a discernable human influence on the climate." He further said, "If we are all to take responsibility for the future of our planet, then it falls to us to begin to take precautionary action now." BP plans to develop alternative fuels such as solar power. It plans to boost solar-power sales to US $1 billion a year in the next decade and will commission a solar-panel plant in California by the end of the year. Shell predicted a shift towards renewable energy resources, with wind, biomass, and solar growing to 5% of the global market by the year 2020 (*Ottawa Citizen*, 22 May 1997). Shell and BP deserve full credit for their policy change, whatever their past environmental infelicities. Maybe their far-sightedness will inspire the rest of the petroleum industry to follow suit. [D.E.M.]

Horse logging training

Forest Renewal BC, a British Columbia crown corporation, has provided the Cariboo Horse Loggers Association (CHLA) with just under $100,000 to train 15 people in selective harvesting techniques over the next year. Training will be given in partial cutting, logging plan development, care for draft hoses, chainsaw maintenance, pre-harvest silviculture prescriptions, stumpage rates, bookkeeping and industrial first aid. The CHLA is organizing a provincial horse loggers's association and is looking for membership.

Contact Cariboo Horseloggers Association, Box 4002, Quesnel, BC V2J 3J2, Tel: (250) 992-9230. [Condensed from *Natural Life*, July–Aug 97 issue]

Cousteau dies

On 25 June 1997 Jacques Cousteau, who brought the beauty of coral reefs to more hearts and minds than any other person in the world, died at the age of 87 in Paris, France. Cousteau was the co-inventor with Gagnon, a French-Canadian engineer, of the Aqua-Lung that enabled humankind to explore the planet's inner space, the 71% of the planet's surface that is covered by the oceans. *Global biodiversity* salutes his life and achievements. [D.E.M.]

DFO launches marine protected areas plan

In January 1997 the Canadian Department of Fisheries and Oceans published a 47-page discussion paper, *An approach to the establishment and management of marine protected areas under the Oceans Act*. The discussion paper — which defines a marine protected area, describes the overall goals, strategies and purposes under the *Oceans Act*, indicates how marine protected areas will be identified, established, and managed — is meant to seek input and comment on the Department's approach to establishing marine protected areas. Three positions have been staffed in the Marine Ecosystems Conservation Branch of Fisheries and Oceans to manage marine protected area commitments.

The paper will also be used to stimulate discussion at regional consultation meetings across Canada. The first such meeting was held 2 May 1997 in Ottawa. For further information contact: H.C. Joseph, Fisheries and Oceans, 200 Kent Street, Ottawa, Ontario K1A 0E6, Canada, by telephone at (613) 990-7389, or by fax at (613) 990-2379. [D.E.M.]

ROM gets new director

The Royal Ontario Museum (ROM) in Toronto, Canada welcomed a new director, Dr. Lindsay Sharp on 1 February 1997. Elizabeth Samuel, Chairperson of the Board of Trustees, said that Dr. Sharp is clearly the person to take the Museum into the future. "Sharp is a dynamic and energetic leader with a strong vision for the role museums play in exploring social and intellectual development and the dynamics between the past, present and future. He is known as a collaborative leader who listens to and values people, those working within the Museum and those served by the Museum."

Dr. Sharp, British born, earned his Ph.D. in Philosophy and History from Queen's College, Oxford. He has a proven track record in museum administration, fundraising, and managing change, key skills the ROM was looking for. [*ASC Newsletter* February 1997; 25(1): 5].

1997 Goldman Environmental Prize awarded

Loir Botor Dingit, Paramount Chief of the Bentian Tribal Council, has been awarded the Goldman Environmental Prize. For the last decade Dingit has worked tirelessly with the help of PLASMA (an Indonesian NGO) and the support of the Biodiversity Support Program (BSP) to ensure the Bentian forest areas and rattan gardens in Indonesia were excluded from proposed conversion to timber plantations. (BSP is a consortium of World Wildlife Fund, The Nature Conservancy and World Resources Institute, funded by the United States Agency for International Development (USAID). This change will keep 150,000 hectares (39 km × 39 km) of forest intact under Bentian stewardship and serves as a precedent for government recognition of traditional resources rights and management practices. For more information contact: Biodiversity Support Program, 1250 24th St. NW, Washington, DC 20037 USA. [BSP 1996 Annual Report]

Loir Botor Dingit (right) and Neil Macinuddin of PLASMA, an Indonesian NGO supported by the Biodiversity Support Program, study a map that documents traditional Dayak resource management practices. (Photo: Patrick Breslin)

North American growing season increasing!

An article in *Nature* (18 April 1997) reported that plant growth increased by 10% between 1981 and 1991 in latitudes north of 45°N. Satellite data indicated that the increase "was associated with an increase in the duration of the active growing season." The authors attribute the changes to increasing carbon dioxide availability and changes in the temperature characteristics of the growing season. You can find the complete paper at <http://www.forestry.umt.edu/ntsg/nature/> [Condensed from a note from David Galbraith of the Canadian Botanical Conservation Network]

Professor Nancy J. Turner recipient of 1997 Richard Evans Schultes Award

Professor Nancy J. Turner of the School of Environmental Studies at the University of Victoria, British Columbia (BC), is the recipient of the 1997 Richard Evans Schultes Award. The Schultes Award is presented annually by The Healing Forest Conservancy to a scientist, practitioner, or organization that has made an outstanding contribution to ethnobotany or to indigenous peoples issues related to ethnobotany.

Turner's impressive scholarly recognition by her peers on the temperate climate ethnobotany of the First Nations in BC — almost 30 books, monographs, or chapters — is surpassed only by the number of her many devoted students whom she has inspired to enter the field of ethnobotany. The award recognizes her outstanding contribution of strengthening indigenous peoples' participation in community-based conservation of biological diversity.

The Healing Forest Conservancy, a non-profit foundation, is dedicated to the conservation of tropical forests, particularly medicinal plants and their sustainable use for human health. Its focus is to deliver compensation programs that strengthen the integrity of traditional cultures to native communities that have participated in Shaman's drug discovery process.

Nominations for the 1998 Richard Evans Schultes Award are open until 1 May 1998. The award seeks a balance in geographic location, gender, and field of study for recipients. Nominations of indigenous people or organizations active in this area are especially welcome. Please submit nominations (of others, it is not self-nominating), along with a statement of the candidate's qualifications to:

Katy Moran, Director, The Healing Forest Conservancy 3521 S Street, N.W. Washington, D.C. 20007 USA, Tel: (202) 333-3438, E-mail: <MoranHFC@aol.com> [D.E.M.]

Full marks for Seven Island Land Company

The Seven Island Land Company owns a 405,000-hectare forest in Maine that has been under sustainable management since 1841. It is the largest forest in the northern hemsisphere to be certified by the Scientific Certification Systems (SCS). Here are some of the SCS marks that the Seven Island Land Company earned: 86% for its sustainable development methods; 88% for the health of the ecosystem; and 94% for the socioeconomic benefits (including work relations). Of its 35 employees, 24 are forestry-trained. Seven Island is so successful that it must refuse contracts. The company has even done a projection for sustainable development for the next 200 years. [Condensed from *La maison du 21ième siècle*, Vol. 4, No. 3, May 1997]

Cyberdiversity:

Biodiversity and the Internet

Forum

"Progress in conserving forest biodiversity through forest management is dependent on sound science."

This statement is part of a paper entitled "We Care About Forest Biodiversity," by Simon Nadeau and Jean-Pierre Martel, Canadian Pulp and Paper Association, which will be published in the Winter issue of *Global biodiversity*. The paper is a response to Jeffrey McNeely's paper, "Who Cares About Forest Biodiversity?" published last fall.

You can find both of these papers posted at <http://www.nature.ca/english/gbfor.htm>.

What exactly qualifies as "sound science"? Are there forestry initiatives based on sound science happening near you? Join in, and let us know. Comments on this special issue on ecoforestry are also welcomed.

Non-timber forest products list

The purpose of "ntfp-biocultural-digest" is to share understanding about the human dimensions of worldwide non-timber forest product (ntfp) use. The list includes postings of research materials, upcoming events, job opportunities, relevant newsletters and news in general about ntfps. People are welcome to schedule week-long discussions by writing to the list caretaker <owner-nftp biocultural@igc.org>.

You can subscribe by sending a message to <majordomo@igc.org> and in the body of your message put "subscribe ntfp-biocultural-digest <your e-mail>".

Canadian forestry sites

Thanks to John Roper, forestry advisor at CIDA, for pointing out these links:

CIDA Forestry Advisers Network (Information on international forestry; includes coming events, directory, resources, and papers in draft form with input welcomed) <http://www.cfan-rcfa.org>

Canadian Forests (Canada's national forestry page with links to all major Canadian forestry sites; also includes CIFAR, a roster of Canadian foresters who are available for international consulting assignments) <http://www.canadian-forests.com>

International forestry sites

Thanks to the Biodiversity Action Network for posting subject-related sites on its Listserv. Here are some of the forestry-related ones:

Community Forestry at FAO <http://www.fao.org/waicent/faoinfo/forestry/ftpp/default.htm>

Forests, Trees and People Programme and Network <http://treesandpeople.lbutv.slu.se/welcome.html>

Gaia Forest Conservation Archives <http://forests.org/gaia.html>

Rainforest Action Network <http://www.ran.org/ran>

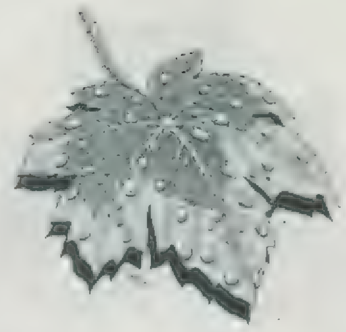
World Commission on Forests and Sustainable Development <http://iisd1.iisd.ca/wcfsd/>

Forest Frontiers Initiative (World Resources Institute) <http://www.wri.org/wri/ffi/>

World Wide Fund for Nature — International <http://www.panda.org/tda/forest/new/index.htm>

Crees and Trees

For an interesting essay on industry, government practices, and boreal forests in northern Quebec, check out "Crees and Trees" written by the Grand Council of the Crees. <http://www.gcc.ca/enviro/foresty/Forestry.htm>



Biodiversity meetings

7–9 NOVEMBER 1997

Our Forest Future: A conference on community survival stategies and "Lands for Life" will discuss sustainable ways of connecting protected areas, tourism, and logging in a healthy forest landscape, and talk about what we *really* want for the future of our forests. To be held in Sault Ste. Marie, Ontario.

Contact: *Wildlands League, Tel: (416) 971-9453*

7 APRIL 1998

Third Annual International Wildlife Law Conference, to be held in Washington, D.C.

Contact: *Wil Burns, GreenLife Society, North American Chapter, 700 Cragmont Ave., Berkeley, CA 94708, USA, Tel/Fax: (510) 558-0620, E-mail: <greenlifesociety@msn.com>*

4–15 MAY 1998

COP-4, the Fourth Conference of the Parties to the Convention on Biological Diversity to be held in Bratislava, Slovakia.

Contact: *CDB Secretariat, World Trade Center, 413 St. Jacques St., Office 630, Montreal, Quebec, Canada H2Y 1N9, Tel: (514) 288-2220; Fax: (514) 288-6588, E-mail: <biodiv@mtl.net>*

1–3 JUNE 1998

The First International Conference on Geospatial Information in Agriculture and Forestry. Decision Support, Technology, and Applications to be held in Lake Buena Vista, FL, USA.

Contact: *Robert Rogers, ERIM, Box 134001, Ann Arbor, MI, USA 48113-4001, Tel: (313) 994-1200 ext. 3234, Fax: (313) 994-5123, E-mail: <raeder@erim.org>*

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Fax, e-mail, or mail your classified (typed or printed clearly) to: Anne Winship, Ad Manager, *Global biodiversity*, PO Box 3443, Station D, Ottawa ON K1P 6P4; Tel: (613) 566-4203; Fax: (613) 566-4763; E-mail: <biodiv@mus-nature.ca>.

Global Freshwater Biodiversity: Striving for Integrity of Freshwater Ecosystems. 140 pp. Ocean Voice International, Box 37026, 3332 McCarthy Road, Ottawa, Ontario K1V 0W0, Canada. E-mail: cx240@freenet.carleton.ca; Fax: (613) 521-4205. $15 postpaid when purchases are pre-paid.

* * *

Sea Wind 11(1) contains an index and table of contents for volumes 6 to 10 of that bulletin, which deals with marine biodiversity and sustainable harvesting of marine resources, from 1992 to 1996. Over 175 articles are indexed under about 1,000 topics. Copies can be ordered via e-mail from cx240@freenet.carleton.ca.

Singles Network Single science/nature enthusiasts are meeting through Science Connection, a nationwide network. Contact us for info: PO Box 599, Chester, Nova Scotia B0J 1J0; E-mail: <71554.2160@compuserve.com>; Tel: (800) 667-5179.

* * *

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Book and periodical niche

Biodiversity II: Understanding and protecting our biological resources

Edited by Reaka-Kudla, M.L., D.E. Wilson and E.O. Wilson. 1997. Joseph Henry Press, National Academy of Sciences, Washington, D.C. 551 pp. ISBN 0-309-05227-0. Hardcover, US $34.95.

This volume provides a view of biodiversity prepared ten years after the chapters in the well-known 1988 volume, *Biodiversity*, which was edited by E.O. Wilson and F.M. Peter, successfully introduced the term to a broad audience. *Biodiversity II* consists of an introduction and 31 chapters divided into six somewhat overlapping parts, dealing with the meaning and value of biodiversity, the diversity of species, threats to biodiversity, the means to understand and use it, potential solutions to current problems, and requirements for the necessary work. An additional chapter by the editors concludes the book.

The range of organisms, habitats, and issues discussed here is very wide. Coverage of the taxa is more balanced than in the 1988 book, and insects, marine invertebrates, and microbes, as well as vertebrates, all get significant treatment. Intended to appeal to both scientists and non-scientists, the book normally defines technical terms and explains complex material. In this and other ways, the volume is generally well edited and produced, and I noticed serious inadequacies of style in only one chapter, and only a handful of errors in typography, spelling, word use, or facts.

The style and content of each chapter is different, as is inevitable in a compilation of this sort. Even so, nearly every chapter brings interesting and relevant facts and thoughtful analysis to the broad subject of biodiversity. Most (but not all) chapters have adequate references to the material discussed (up to 130 citations per chapter, normally between 30 and 50), which allow the reader to follow-up. Collectively, the chapters bring together an impressive range of material which provides the basis for characterizing, understanding, and protecting biodiversity. This includes the necessary scientific operations; selection of tasks; training, use, and expansion of expertise; collaboration among organizations; and assembly, integration, and dissemination of data.

No review of a volume of such scale and scope could do justice to its detailed content. Suffice it to note, first, that there is a wide sampling of facts and documentation. Estimates of species in many groups are given, and remarkable and unexpected diversity is shown for microbes and invertebrates in some habitats, including coral reefs. A bias toward vertebrates and moist tropical forests is identified in current data. Many losses of species and habitats are defined (with some hand-wringing). Long-term trends of extinction caused by humans can be recognized (e.g. on oceanic islands) in addition to more recent extinctions.

Second, many good ideas are offered about candidate systems, species and habitats, and the need for proactive rather than reactive solutions. Many of these features are already known of course, or known to some degree, but they are reinforced here. For example, the biological context (such as habitat and microhabitat) of species is especially important, there are wide differences among groups, and it is individual species, not communities as such, that respond to change.

Third, several prescriptions for improving knowledge or ensuring conservation are offered. New techniques are introduced, systematics and collections are recognized as critical, and because there is no such thing as a typical species, protection requiring a range of diversity and targetting multiple areas is supported. However, in my view, current theory and tools for conservation should have been more thoroughly covered.

Naturally, not all authors of the different chapters agree with one another. For example, there are differing views on conserving species versus conserving habitats, and on the need for area-specific all-taxa biodiversity inventories (ATBI) versus the need for systematics work with a much broader geographical coverage.

Several points are demonstrated repeatedly. They include the importance of interrelationships in nature (and hence the complexity of studies and actions to protect biodiversity), the need for systematics expertise and infrastructures (such as collections of specimens and databases of adequate scale and connectivity), the need to study specific natural histories, and the social will and detailed information that are required for effective conservation actions. Indeed, the scale of the problems now require basic work on biodiversity to be treated as "big science" with adequate funding.

Its general content notwithstanding, the volume has some flaws. The authorship and orientation of this book toward the global implications of threats to biodiversity are overwhelmingly American, perhaps largely because of its origin in a consortium based in the eastern United States; only one of the 47 authors comes from outside the United States. All of the rest have US affiliations, and more than two thirds of them are from Washington, DC and nearby Maryland (which admittedly have a large concentration of relevant specialists). Consequently, some worthwhile contributions to the understanding of biodiversity from scientists in other countries have been overlooked or undervalued. Relevant projects and ideas from Australia (with exceptions), Canada, South Africa, South America, and the United Kingdom (with exceptions) do not figure here, and no references are cited by experts from such countries, for example, in the fields of diversity and conservation. Chapters on potential solutions reflect mainly US initiatives. The chapters lack abstracts, which would have been a very effective way of guiding the reader through a book with such varied content, especially a reader who was looking for information and ideas but who might not want to read nearly 250,000 words to find them. The index fulfills this role incompletely.

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The concluding chapter is disappointing. For the most part, it reiterates in a serial fashion a few points from each chapter, whereas the reader might have expected a more forceful synthesis of key concepts.

Despite these caveats, *Biodiversity II* is a valuable source of information and ideas, a call for action, and a confirmation that the tools for that action are available if only society can focus its general concerns with biodiversity on resources for major coherent programs, including support for the systematics work and infrastructures essential for studies of biodiversity. One objective of the volume was to educate students, teachers, scientists, policy makers, and the public. "We hope to have instilled in this broad audience," the editors write in their concluding sentence, "the idea that we can and must act now."

Since *Biodiversity II* went to press, some policies for the entirely or chiefly US-funded endeavours that are emphasized in this book have changed (as has the focus of the Costa Rican ATBI). Meanwhile, new scientific discoveries continue to be made. Therefore I look forward to seeing the additional ideas and progress, as well as the broader authorship and reference, that will be possible when "Biodiversity III" is published.

H.V. Danks, Biological Survey of Canada (Terrestrial Arthropods), Canadian Museum of Nature

Ecoforestry: The art and science of sustainable forest use

Edited by Alan Drengson and Duncan Taylor. 1997. New Society Publishers, P.O. Box 189, Gabriola Island, BC, V0R 1X0. 312 pp, cloth ISBN 0-86571-364-2.

What sets ecoforestry apart from industrial forestry? At its worst, according to Alan Drengson, "Industrial forestry simplifies ecosystems, systematically removes natural forests and replaces them with monoculture plantations." Jerry Mander explains that an ecoforester recognizes forests' intrinsic value, and ecoforestry ultimately becomes "a moral and spiritual undertaking and commitment at the highest level."

Any movement that has Gary Snyder as one of its gurus has a lot going for it. His reflections on crawling through manzanita had a special resonance for me, as a new father. And when I read the following passage from Duncan Taylor to my wife — "If the world 'out there' mirrors my inner one, then in a very real way its transformation begins with the transformation of myself" — she exclaimed delightedly, "The ecologists are starting to catch on!"

Besides these philosophical gems, the 35 contributors to *Ecoforestry* offer practical advice for woodlot managers, insights on traditional aboriginal practices, and analyses of forest policies in Scotland and Switzerland. They also address forest fungi, snags, coarse woody debris, and fire — evidence that science remains one of the underpinnings of ecoforestry.

Most authors focus on temperate forests, particularly those on the west coast of North America. An exception is George Matz's essay, "The Worth of a Birch." Matz describes the surprising diversity of small-scale, value-added forest industry near Fairbanks, Alaska (birch syrup, bark baskets, panelling, furniture, and cabinets, bowls): boreal communities take note.

Ecoforestry is very much a work in progress, with considerable debate among practitioners. Orville Camp would "allow nature to set the 'desired future conditions.'" But James Agee warns that "using the patterns of the past, even when correctly interpreted, as a narrow guide to the future is far too constraining." He argues that fire breaks and understory burning are needed to undo the past legacy of fire control, which has greatly increased the potential for catastrophic fire in the Pacific Northwest, and threatens both timber resources and spotted owl habitat.

Landscape management approaches represent a serious challenge for ecoforestry. Can and should ecoforestry move beyond its roots (i.e., careful selection harvests on individual private forests) to address more complex issues of multiple ownership and public land forestry? Herb Hammond suggests that watersheds will provide the means of extending ecoforestry to the landscape level, but much remains to be done.

Some contributions fall short of the mark. Alan Wittbecker's attempt to use ecological energetics as a theoretical basis for ecoforestry is misguided, in my view. The idea that net primary productivity (NPP) "should be the basis for the AAC" (annual allowable cut) is sheer nonsense, and would have highly undesirable results if implemented. And Lutz Faehser's essay on forest genetics is little more than a diatribe against clear-cutting and planting exotic species.

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Is there common ground between industrial forestry and ecoforestry? As Alan Drengson notes, human knowledge of how forest ecosystems function is very limited. Hence, there must be a focus on keeping the parts intact — on composition and structure. Species diversity, old-growth stands, snags, multiple canopy layers, etc. are measurable aspects of forests that indicate how well forestry is succeeding at sustaining all values. Conservation of biodiversity is, in my opinion, where ecoforestry and industrial forestry are likely to converge.

Olé Hendrickson, Natural Resources Canada

The rain forests of home: Profile of a North American bioregion

Edited by Peter K. Schoonmaker, Bettina von Hagen, and Edward C. Wolf. 1997. Island Press. 480 pp. Paperback. ISBN 1-55963-480-4. US $27.00

Grasping the complexity, scale and value of a bioregion is a difficult challenge. Yet, only this depth of understanding will help humans live in ways that nurture rather than exploit the Earth. By creating a rich profile of the coastal temperate rainforests of North America, *The Rain Forests of Home* serves as a resource and inspiration for people working to revitalize the cultural and ecological health of this region.

The sponsors and editors of this book, Ecotrust and Interrain Pacific, two affiliated organizations based in Oregon, are working to define and implement the emerging field of "conservation-based development." In 1994, they convened a conference of ecologists, sociologists, activists, Native Americans, and others to set the stage for this field and the book. According to them, conservation-based development goes beyond the traditional conservationist approach of setting aside protected land in reserves. It is about figuring out enduring ways to live with and in nature, rather than just along side it. The editors place this vision amid a context of problems and opportunity. Majestic ancient forests, embarrassingly low salmon runs, human ingenuity, abandoned logging towns, and rich coastal estuaries are the raw materials from which sustainable initiatives evolve.

The book reads like an interdisciplinary textbook, with each chapter giving scientific descriptions and history lessons about the ecological and social dynamics of the region. Unfortunately, this format makes for some

Should Trees Have Standing? And Other Essays on Law, Morals, and the Environment

Christopher Stone
Published 1996. 181pages. US$30.00
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Originally published in 1972, ***SHOULD TREES HAVE STANDING? -TOWARD LEGAL RIGHTS FOR NATURAL OBJECTS*** immediately became a rallying point of the then nascent U.S. environmental movement and has since become a classic worldwide.

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reading heavy with jargon. Overall though, it is a good read; the book is peppered with lively sections called "concepts in action." These practical examples leave the reader with concrete ideas about what sustainability looks like, from cottage industries based on wild-mushroom harvesting to grassroot efforts to restore salmon runs.

What is lacking is a sense that there is actually a *crisis* facing the rainforests of the Pacific Coast. The editors note that the book's purpose is to focus on the positive vision of healthy human-Earth communities, rather than the ugly reality of forest destruction. I think, however, that they have underestimated the power of tears and rage. People are moved to action as much by outrage in the face of greed, waste, and shortsightedness, as they are by hope and opportunities. The book might convince more people that widespread social change is needed, if it conveyed the gut-wrenching feeling that comes from seeing the devastating moonscapes, called clear-cuts, that scar this region.

As for solutions, there are few accounts of what is being done to challenge multinational corporations that are exploiting the rainforest in the drive for short-term profits. Although Ecotrust explicitly points to the value of local ownership, they do not offer a clear path of how to overcome the central and formidable barrier to sustainability presented by the global economy.

In the end, there are still some pressing questions: What will it take to avoid being crushed by the steam-roller of global capitalism? Do we have enough time to wait for the slow process of conservation-based development to emerge? How much of our ecosystem must be protected from our cultural experiments, in order to truly safeguard the Earth as we know it?

When activists, policy-makers, townspeople, and scientists from Maine to British Columbia answer these questions, then the Earth's ecosystems might have a chance. Until then, *The Rain Forests of Home* is a good start.

Kristin DeBoer, RESTORE: The North Woods

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Biodiversity and Conservation of Neotropical Montane Forests (Proceedings of the Neotropical Montane Forest Biodiversity and Conservation Symposium. The New York Botanical Garden, 21-26 June 1993). Steven P. Churchill, Henrik Balslev, Enrique Forero, and James L Luteyn eds. 1995. The New York Botanical Garden, Bronx, NY 10458-5126. Hardcover, 702 pp. ISBN 0-89327-400-3. US $85.00.

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Les vrais maîtres da la forêt québécoise. By Pierre Dubois. 1995. Les Éditions Écosociété. Montreal. ISBN 2-921561-23-9, 118 pp. (Reviewed in *La biodiversité mondiale* 7(2): 60.)

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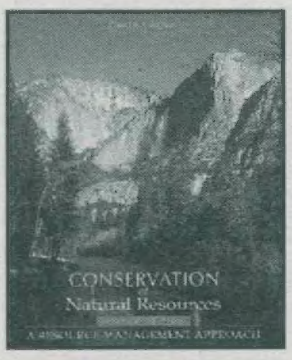

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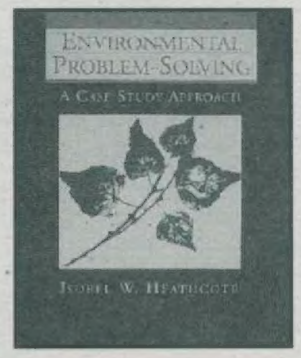

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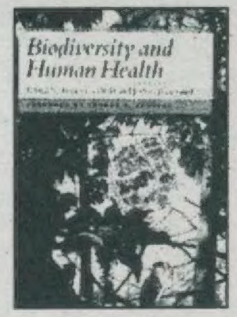

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